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CONTENT

BIOLOGICAL SCIENCES

Babayeva F.
CORE MECHANISM OF HERPES SIMPLEX VIRUS LATENCY AND MECHANISMS OF ACTION OF PLANT EXTRACTS IN COMBINATION WITH ANTIVIRAL DRUGS 3

ECONOMIC SCIENCES

Urinov B.
MIDDLE MANAGEMENT ROLE IN IMPLEMENTING QUALITY ASSURANCE STANDARDS IN HIGHER EDUCATION 10

Zhumadullaeva D.
ANALYSIS OF THE CORPORATE GOVERNANCE SYSTEM IN THE BANKING SECTOR OF UZBEKISTAN 16

PEDAGOGICAL SCIENCES

Kuttuguzhina Zh., Kudaibergenova K.
SCHOOL LEADERSHIP AND TEACHERS' LEADERSHIP POTENTIAL: A COMPARATIVE STUDY OF DIFFERENT TYPES OF SCHOOLS. HOW SCHOOL LEADERSHIP DEVELOPS TEACHERS' LEADERSHIP POTENTIAL: PERSPECTIVES OF KAZAKHSTANI TEACHERS 21

PHILOLOGICAL SCIENCES

Mardanova S.
THE SUBJECT AND MAIN RESEARCH DIRECTIONS OF THE STYLISTICS 27

POLITICAL SCIENCES

Sultanli S.
SOFT POWER AND CULTURAL DIPLOMACY IN THE SOUTH CAUCASUS.....31

SOCIAL SCIENCES

Pak L., Shadmanova A.
ARCHAEOBOTANICAL EVIDENCE AS REFLECTION OF HEALING AND RITUAL PRACTICES (INTERDISCIPLINARY APPROACH BASED ON ARCHAEOLOGICAL DATA).....37

TECHNICAL SCIENCES

Komitov D.
OPERATIONAL CHALLENGES OF AUTONOMOUS MARITIME NAVIGATION UNDER EXTREME AND ABNORMAL CONDITIONS.....42

Polovynko I.
OPTIMIZATION OF LOSSLESS IMAGE COMPRESSION METHODS 45

BIOLOGICAL SCIENCES

ОСНОВНЫЕ МЕХАНИЗМЫ ЛАТЕНТНОСТИ ВИРУСА ПРОСТОГО ГЕРПЕСА И МЕХАНИЗМ ДЕЙСТВИЯ РАСТИТЕЛЬНЫХ ЭКСТРАКТОВ ПО СРАВНЕНИЮ ПРОТИВОВИРУСНЫХ ПРЕПАРАТОВ

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CORE MECHANISM OF HERPES SIMPLEX VIRUS LATENCY AND MECHANISMS OF ACTION OF PLANT EXTRACTS IN COMBINATION WITH ANTIVIRAL DRUGS

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Аннотация

Вирус простого герпеса являются широко распространёнными нейротропными ДНК-вирусами человека. Его высокая эпидемиологическая значимость обусловлена не только частотой первичного инфицирования, но и уникальной способностью к длительному сохранению в организме. Одной из ключевых биологических особенностей этих вирусов является их способность формировать пожизненную латентную инфекцию в периферических сенсорных нейронах. Латентная персистенция вируса простого герпеса в нейронах обусловлена под воздействием комплекса факторов: нейротропизм, эписомальным сохранения вирусного генома, ретроградным аксональным транспортом, регуляторной функции LAT-транскриптов и иммунологических особенностей нервной ткани. Данная комплексная адаптационная стратегия обеспечивает пожизненное сохранение вируса в организме человека и его способность к периодической реактивации.

Поскольку репликация вирусов герпеса осуществляется внутриклеточно, разработка эффективных противовирусных препаратов требует высокой степени избирательности действия. Лекарственный препарат должен целенаправленно подавлять вирусную активность, не нарушая при этом нормольного функионирования клетки-хозяина. Ключевым механизмом дейсвия современных препаратов является ингибирование синтеза вирусной ДНК. Примерами этих препаратов являются видарабин, валацикловир, ацикловир. Препарат активируется основном в клетках поражённых вирусом, где и превращается в активную форму. Активная форма препарата ацикловир подавляет вирусную ДНК-полимеразу, что приводит к остановке репликации вируса. Благодаря этому препарат оказывает селективное действие и практически не влияет на здоровые клетки.

Формирование резистентности к широко применяемым антигерпетическим препаратам и развитие их нежелательных побочных эффектов стали серьёзной клинической проблемой. В этом контексте особое внимание привлекают препараты растительного происхождения благодаря их эффективности и безопасности. Сообщалось о выполнении скрининговых исследований антигерпетической активности экстрактов лекарственных растений и вторичных метаболитов растительного происхождения. Для эфирных масел были описаны антибактериальные, иммуномодулирующие и противовоспалительные свойства.

Клинические штаммы вируса простого герпеса 1-го типа, устойчивые к ацикловиру, были исследованы в условиях in vitro на чувствительность к эфирным маслам имбиря, тимьяна, иссопа, сандалового дерева и к гидроалкогольному экстракту корицы. Все эфирные масла, также гидроалкогольный экстракт корицы проявили высокую вирулицидную активность, значительно уменьшая образование вирусных колоний.

Abstract

Herpes simplex virus is a widerspread neurotropic DNA virus among humans. The high epidemiological significance of herpes simplex virus is associated not only with its ability to cause primary infection but also with its capacity to establish long-term persistence in the host. One of the biological characteristics of these viruses is their ability to establish lifelong latent infection in peripheral sensory neurons. The establishment of herpes simplex virus latency in neurons is mediated by several complex mechanisms; neurotropism, episomal persistence of the viral genome, retrograde axonal transport, regulatory function of LAT transcripts and the immunological characteristics of nervous tissue. This complex adaptive strategy ensures the lifelong persistence of the virus in human body and its ability to undergo periodic reactivation.

Since herpes simplex virus replication is an intracellular process, the development of effective antiviral drugs requires a high degree of selectivity. Antiviral drugs should selectively inhibit viral activity without disrupting the normal functions of human cells. The primary mechanism of action of modern antiviral drugs is the inhibition of viral DNA synthesis. Examples of these antiviral drugs include vidarabine, valacyclovir, acyclovir. The drug is primarily activated in virus-infected cells, where it undergoes conversion to its active form. The active form of

acyclovir inhibits viral DNA polymerase, thereby preventing viral replication. As a result, the drug exhibits selective activity and has minimal effects on healthy cells.

The emergence of resistance to antiviral drugs and their associated adverse effects represent a serious clinical problem. In this context, increasing attention has been focused on effective and safe plant-derived therapeutic agents. Screening studies have been reported on the anti-herpetic activity of extracts from medical plants and plant-derived secondary metabolites. The study concluded that essential oils exhibit antibacterial, immunomodulatory and anti-inflammatory properties.

The susceptibility of clinical acyclovir-resistant herpes simplex virus type 1 strains to the essential oils of ginger, thyme, hyssop, sandalwood, as well as to the hydroalcoholic extract of cinnamon was examined in vitro. All essentials oils, as well as the hydroalcoholic extract of cinnamon, exhibited high antiviral activity and substantially reduced the formation of viral plaques.
Ключевое слова: Вирус простого герпеса (ВПГ) , ацикловир, корица, сандал, тимьян, лимонен, иссоп.

Keywords: Herpes simplex virus (HSV), acyclovir, cinnamon, sandalwood, thyme, limonene, hyssop.

Вирусы это микроскопические инфекционные агенты, которые могут размножаться только внутри живых клеток. Они не имеют собственной клеточной структуры и состоят из генетического материала (ДНК или РНК), покрытого белковой оболочкой.

Герпесвирусы представляет собой линейный двуцепоченный ДНК вирус относящийся к подсемейству Alphaherpesviridae. У герпесвирусах в центральной части располагается крупные ДНК, диаметр которых составляет 150–200 нм. ДНК окружённая икосаэдрическим капсидом, состоящим из 162 капсомеров. Снаружи вирус покрыт оболочкой с гликопротеиновыми выростами. Между капсидом и оболочкой имеется пространство, называемое тегументом, в котором находятся белки и ферменты, необходимые для репликации вируса.

Вирус простого герпеса подразделяется на два антигенных типа: тип 1 (ВПГ-1) и тип 2 (ВПГ-2). Вирус простого герпеса является важным патогеном для человека, который инфицирует и размножается в клетках в месте проникновения на слизисто-кожной поверхности. Латентный вирус может спонтанно реактивироваться, вызывая у некоторых людей частые рецидивирующие инфекции, тогда как у большинства людей рецидивы возникают редко. Инфекции ВПГ-1 очень распространены и в основном поражают взрослых людей.

ВПГ-1 источником инфекции являются больные люди и вирусоносители. ВПГ в основном передаётся контактным путём, иногда — воздушно-капельным. Заражение чаще всего происходит среди людей в раннем возрасте. ВПГ-2 передаётся преимущественно контактным путём, в том числе половым, поэтому заражение этим вирусом наблюдается после начала половой жизни. Также вирус может передаваться от матери плоду трансплацентарным путём во время родов.

Инфекции, вызываемые вирусом простого герпеса типа 1, относится к числу из наиболее распространённых инфекций среди людей. Его высокая эпидемиологическая значимость обусловлена не только частотой первичного инфицирования, но и уникальной способностью к длительному сохранению в организме. Во время заражения образующиеся антитела не способны полностью устранить вирус, поэтому вирус остаётся латентным в чувствительных ганглиях организма хозяина, и человек становится пожизненным носителем.

Поскольку репликация вирусов герпеса осуществляется внутриклеточно, разработка эффективных противовирусных препаратов требует высокой степени избирательности действия. Лекарственный препарат должен целенаправленно подавлять вирусную активность, не нарушая при этом нормольного функионирования клетки-хозяина и тем самым минимизировать повреждение клеток. Ключевым механизмом дейсвия современных препаратов является ингибирование синтеза вирусной ДНК. Блокируя процесс репликаии генетического материала вируса, данные средства препятствуют его дальнейшему размножению в организме. Примерами этих препаратов являются видарабин, йододезоксиуридин и ацикловир.

ВПГ -1 и ВПГ- 2 являются широко распространёнными нейротропными ДНК-вирусами человека. Одной из ключевых биологических особенностей этих вирусов является их способность формировать пожизненную латентную инфекцию в периферических сенсорных нейронах. Латентность характеризуется прекращением активной вирусной репликации при сохранении вирусного генома в ядре клетки.

Первичная инфекция вируса простого герпеса протекает в лёгкой форме и часто бывает бессимптомной. Вируса простого герпеса 1 типа проникает в организм преимущественно через слизистые оболочки полости рта, носоглотки. В месте внедрения происходит первичная репликация вируса в эпителиальных клетках. После первичной репликации вирус проникает в окончания чувствительных нейронов и посредством ретроградного аксонального транспорта доставляются в ганглии (ВПГ-1 в тройничный ганглий, ВПГ-2 в крестцовые ганглии), где формируется латентная инфекция. При этом нейроны не погибают, однако в их составе вирусный геном сохраняется в виде свободной кольцевой эписомы.

В латентно инфицированных ганглиях около 1% нейронов содержат вирусный геном. Вирусный геном сохраняется в ядрах нейронов без репликации в виде эписомы. В последние годы в инфицированных нейронах была обнаружена небольшая молекула РНК-микроРНК, кодируемая вирусным геномом. МикроРНК предотвращает гибель нейронов и способствует персистенции латентной инфекции. Большинство людей (примерно 80%) являются

пожизненными носителями вируса, который сохраняется в их нервных узлах, вызывая латентную инфекцию в нейронах.

В латентно инфицированных ганглиях вирусы сохраняются пожизненно. При ослаблении иммунитета под воздействием провоцирующих факторов (повышение температуры, стресс, ультрафиолетовое излучение и др.) происходит реактивация герпесвирусов. Он возобновляет репликацию, ДНК герпесвируса по аксону перемещается обратно к чувствительным нервным окончаниям, где в эпителиальных клетках происходит репродукция вируса.

Обострения герпесвирусной инфекции, как правило, при рецидивах обычно протекают легче, поскольку организм уже выработал иммунный ответ. Однако лишь у части людей с латентной вирусной инфекцией наблюдаются клинические проявления. У некоторых людей реактивация вируса может вообще не сопровождается никакими клиническии признаками.

Основные механизмы латентности ВПГ.

Нейротропизм и транспорт в ганглии-Первичная инфекция ВПГ-1 как правило, развивается в эпителиальных клетках. После локальной репликации вирус захватывается периферическими, сенсорными нейронами. Посредством ретроградного аксонального транспорта вдоль микротрубочек вирусные частиы перемещается в периферические сенсорные ганглии, где и устанавливается латентная инфекция.

Эписомальное сохранение вирусного генома-После проникновения в ядро нейрона линейная двухцепочечная ДНК вируса циркуляризуется, принимая форму эписомы. В латентной фазе экспрессия большинства генов кодирующих белки литического цикла подавляется, что обеспечивает длительное сохранение вируса в организме без повреждения клетки хозяина.

Роль LAT (Latency-Associated Transcripts)- Молекулярным маркером латентной инфекции является экспрессия LAT некодирующих РНК, которые активно экспрессируются в латентно инфицированных нейронах. Их основные функции это экспрессии литических генов, ингибирование апоптоз инфицированных нейронов, способствуют стабильному сохранению вирусного генома, участвуют в регуляции реактивации вируса. Таким образом, LAT-транскрипты играют ключевую роль в обеспечении длительной персистенции вирусного генома в нервной ткани.

Иммунологические особенности нейронов- Нейроны являются терминально дифференцированными клетками, не способными к делению, что делает их особенно воспримчивыми к действию иммунной системы организма. Их повреждение представляет серьёзную угрозу для организма, поэтому иммунная система ограничивает выраженность цитотоксических реакций в нервной ткани. Данная особенность проявляется в сниженной экспрессии молекул MHC I в нейронах. Сенсорные ганглии рассматриваются как относительно иммунопривилегированная зона. Эти особенности создают условия для персистенции вирусных частиц от иммунной элиминации.

Механизм реактивации-Под воздействием стрессовых факторов, иммунодефицита и других различных триггеров возможна реактивация латентного вирусного генома. В этот период латентный вирус переходить в активную фазу, возобновляется экспрессия литических генов, происходит репликация вирусной ДНК и посредством антероградного аксонального транспорта вирусные частицы возвращается из нейронов обратно в периферические ткани, вызывая клинический рецидив заболевания.

Латентная персистенция вируса простого герпеса в нейронах обусловлена под воздействием комплекса факторов: нейротропизм, эписомальным сохранения вирусного генома, ретроградным аксональным транспортом, регуляторной функции LAT-транскриптов и иммунологических особенностей нервной ткани. Данная комплексная адаптационная стратегия обеспечивает пожизненное сохранение вируса в организме человека и его способность к периодической реактивации.

Микробиологическая диагностика ВПГ.

Метод	**Материал**	**Чувствительность**	**Цель**
ПЦР	Соскоб, кровь, СМЖ	Очень высокая	Обнаружение ДНК вируса
ИФА	Кровь(сыворотка)	Высокая	IgM(появляются на 1-2 неделе заболевания.Исчезают через 4-6 недель.) IgG(появляются на 3-4 неделе заболевания и сохраняются пожизненно)
Культуральный метод	Соскоб, СМЖ	Средная	Изоляция и идентификаия вируса
РСК	Кровь	Средная	Нарастание титра антител

Противовирусные препараты и их механизм действия.

Большинство противовирусных средств представляют собой нуклеозидные аналоги и применяются в форме пролекарств. Попадая в организм они приобретают фармакологическую активность в инфицированных клетках. Вирусная тимидинкиназа осуществляет первичное фосфорилирование, после чего под действием клеточных ферментов молекула преобразуется в активную трифосфатную форму.

Активированный препарат обладают высокое сродство к вирусной ДНК-полимеразе и конкурентно ингибируют её активность. Встраивание препарата в синтезируемую цепь вирусной ДНК приводит к преждевременному прекращению её удлинения (терминации цепи), что обусловлено отсутствием 3-гидроксильной группы, необходимой для образования следующей фосфодиэфирной связи. В результате становится терминация синтеза ДНК, подавляется репликация вирусного генома и блокируется образование полноценных вирионов.

Отдельные противовирусные препараты реализуют свой эффект посредством прамого блокирования пирофосфатсвязывающего участка вирусной ДНК-полимеразы и не нуждаются предварительной активации тимидинкиназой, что обеспечивает их еффектность в отношении штаммов с дефицитом тимидинкиназы.

Следует отметить, что противовирусные препараты эффективны только в фазе активной репликации вируса. При латентной форме инфекции, характеризующуюся персистенцией вирусного генома в сенсорных ганглиях без активного размножения, терапевтический еффект не наблюдается.

Таким образом, противовирусная терапия при ВПГ инфекци направлена на селективное ингибирование синтеза вирусной ДНК и подавление репликации вируса, однако не способно полной элиминации из организма.

Для лечения первичных и повторных эпизодов вирус простого герпеса применяются противовирусные препараты. Они уменьшают длительность и степень тяжести симптомов, но не устраняют инфекцию полностью. Наиболее эффективным лечение является в течение первых 48 часов после появления симптомов. Чаще всего применяются препараты ацикловир, фамцикловир, валацикловир. Они используются для сокращения продолжительности и уменьшения степень тяжести клинических симптомов, а также могут подавлять сам вирус. Ежедневный приём сниженных доз препаратов (супрессивная терапия) помогает уменьшить частоту рецидивов.

В связи с этим препарат ацикловир активно применяется при лечении поражений вызванных ВПГ-1, он считается селективным противовирусным препаратом, поскольку селективно фосфорилируется тимидинкиназой (ТК), кодируемой ВПГ.

Ацикловир-противовирусный препарат, активно используется для лечения герпесвирусных инфекций. Препарат одобрен для лечения генитального герпеса и герпетического энцефалита.

Противовирусный эффект ацикловира основан на ингибировании синтеза вирусной ДНК. Препарат активируется основном в клетках поражённых вирусом, где и превращается в активную форму.

Активная форма препарата ацикловир подавляет вирусную ДНК-полимеразу, что приводит к остановке репликации вируса. Благодаря этому препарат оказывает селективное действие и практически не влияет на здоровые клетки.

При продолжительном или высокодозном применении необходимо контролировать функцию почек (уровень креатинина). Следует соблюдать осторожность при одновременном применении с нефротоксичными препаратами.

Ацикловир является эффективным и широко используемым противовирусным препаратом для лечения герпесвирусных инфекций. При правильном применении и соответствующем мониторинге это препарат считается безопасным и может иметь жизненно важное значение, особенно у пациентов с иммунодефицитом.

Противогерпетическая активность растительных экстрактов.

В последние годы из-за развития лекарственной устойчивости и побочных эффектов химических препаратов, особенно ограничений при использовании во время лактации, повыситься интерес к замене химических препаратов растительными средствами. На самом деле использование лекарственных растений имеет древнюю историю, изучалось действие различных экстрактов против ВПГ-1.

Появление резистентность вируса простого герпеса к широко применяемым антигерпетическим препаратам превратилась в одну из наиболее значимых клинических проблем, особенно у пациентов с иммунодефиитными состояниями. Поэтому это обстоятельство закономерно стимулирует активный поиск альтернативных антигерпетических средств, эффективных против устойчивых вирусов и не вызывающих тяжёлых побочных эффектов. Устойчивость ВПГ к ацикловиру и его аналогам в основном обусловлена мутациями в гене тимидинкиназы (ТК), что приводит к нарушению первичного фосфорилирования препаратов и делает их фармакологически неактивными. Кроме того мутации в гене ДНК-полимеразы также могут быть причиной устойчивости.

Таким образом, разработка новых альтернативных антигерпетических препаратов, способных блокировать репликацию вируса вне зависимости от активности тимидинкиназы, продолжает оставаться важным актуальным направлением новейшей противовирусной фармакологии.

Для лечения герпетических инфекций необходимо искать новые лекарственные препараты, поскольку у некоторых штаммов герпеса наблюдается вирусная резистентность. Несмотря на то, что ацикловир является ключевым препаратом выбора при лечении поражений, вызванных вирусом простого герпеса, он способен проявлять максимальный противовирусный эффект только в течение первых 72 часов после появления клинических симптомов. Местная кремовая форма ацикловира эффективна лишь при применении в начале латентного периода. Кроме того, имеющиеся побочные эффекты препарата повысили интерес к новым лечебным средствам, вызывающим меньше осложнений. В этом контексте особое внимание привлекают препараты растительного происхождения благодаря их эффективности и безопасности.

Некоторые исследования оценивали ингибирующее действие на вирус растительных экстрактов

на разных стадиях, поскольку первые вирусные полипептиды или альфа-полипептиды, участвующие в снижении синтеза клеточных белков, появляются в различные временные интервалы. Другие исследования проводились в двух этапах, до и после инфицирования вирусом.

Сообщалось о выполнении скрининговых исследований антигерпетической активности экстрактов лекарственных растений и вторичных метаболитов растительного происхождения. Для эфирных масел были описаны антибактериальные, иммуномодулирующие и противовоспалительные свойства. Ранее была показана антигерпетическая активность нескольких эфирных масел различного растительного происхождения, а также некоторых компонентов эфирных масел.

Некоторые фенилпропаны, тритерпены и сесквитерпены были исследованы на предмет их противовирусной активности в отношении различных герпесвирусов. Монотерпены как основные компоненты эфирных масел, например альфа-терпинен, гамма-терпинен, альфа-пинен, альфа-терпинеол, тимол и цитраль были исследованы in vitro на противовирусную активность против вируса простого герпеса 1 типа.

Эфирные масла представляют собой сложную состав низкомолекулярных соединений; монотерпенов, производных фенилпропаноидов и небольшого количества дитерпеноидов. Предполагается, что активными компонентами являются липофильные вещества, взаимодействующие с липидной мембраной. Эти компоненты могут оказывать на вирусную оболочку действие.

Эфирные масла представляют собой сложные комплексные составы, содержащие несколько соединений, относящихся к различным функциональным группам. В зависимости от их структуры их можно разделить на монотерпены, фенилпропаны и другие компоненты. В исследовании противовирусное действие растительных экстрактов были изучены два монотерпеновых соединения эфирных масел, β-пинен и лимонен в условиях in vitro против вируса простого герпеса типа 1. Все противовирусные тесты проводились с использованием клеток RC-37. Цитотоксичность определяли методом нейтрального красного (neutral red assay). Противовирусные исследования проводились на штамме KOS вируса простого герпеса типа 1. Механизм противовирусного действия оценивали на различных стадиях репликационного цикла вируса. Ацикловир использовался в качестве положительного противовирусного контроля. β-пинен и лимонен снижали инфекционность вируса на 100%. Был установлен механизм противовирусного действия, показавший, что данные монотерпены проявляют лишь ограниченный противовирусный эффект при применении до инфицирования клеток или после проникновения вируса в клетку. Однако оба монотерпена выявили высокую противогерпетическая активность в результате прямого взаимодействия со свободными вирусными частицами.

Интересно, что устойчивые к ацикловиру клинические штаммы значительно ингибировались эфирными маслами, а титр ВПГ снижался на 95,9–99,9%. Это подтверждает, что механизм действия эфирных масел отличается от механизм действия ацикловира. Ацикловир блокирует ДНК-полимеразу внутри клетки и тем самым подавляет размножение вируса, тогда как эфирные масла, вероятно, инактивируют вирус ещё до проникновения в клетку.

Эти результаты показывают, что монотерпены, содержащиеся в эфирных маслах, проявляют противогерпетическую активность на ранней стадии репликации вируса и могут использоваться в качестве потенциальных противовирусных средств.

Для системного применения эфирных масел требуются высокие дозы, что может вызывать цитотоксическое действие на клетки. Кроме того, их сниженная биодоступность ограничивает системное использование. Поэтому альтернативные средства эффективные против устойчивых вирусов, особенно для местного лечения, представляют большой интерес.

Клинические штаммы вируса простого герпеса 1-го типа, устойчивые к ацикловиру, были исследованы в условиях in vitro на чувствительность также к эфирным маслам имбиря, тимьяна, иссопа и сандалового дерева. Все эфирные масла проявили высокую вирулицидную активность как против чувствительного к ацикловиру штамма KOS, так и против устойчивых клинических штамм ВПГ-1, значительно уменьшая образование вирусных колоний.

Исследовались эфирные масла, полученные из имбиря (Zingiber officinale), тимьяна (Thymus vulgaris), иссопа (Hyssopus officinalis) и сандалового дерева (Santalum album). Основными компонентами масла имбиря (примерно 5–10%) являются сесквитерпены, такие как зингиберен, сесквифелландрен и куркумен. Масло тимьяна в основном состоит из тимола и карвакрола. Масло иссопа главным образом содержит монотерпены, включая 1-пиносамфон, изопиносамфон и α-пинен. Масло сандалового дерева преимущественно состоит из сесквитерпеновых спиртов, таких как санталол и сантален.

Все эфирные масла растворялись в этаноле и добавлялись в среду для оценки цитотоксичности (конечная концентрация этанола составляла 1%). Эти тесты проводились для определения жизнеспособности, также увеличение числа клеток.

Цитотоксическая концентрация, уменьшающая количество клеток на 50% (CC50), и эффективная концентрация, уменьшающая количество вирусных бляшек на 50% (EC50), рассчитывались по кривым доза-ответ. Индекс селективности вычислялся как отношение CC50/EC50. Для масел имбиря и иссопа индексы селективности составили соответственно 20 и 75.

Максимальные нетоксичные дозы эфирных масел были определены следующим образом; для имбиря — 0,003%, для тимьяна и иссопа — 0,005%, для сандалового дерева — 0,0006%.

Ингибирующее действие эфирных масел против вирус простого герпеса исследовали на разных стадиях инфекционного цикла. Для определения

стадии блокирования репликации клетки вирус обрабатывали эфирными маслами за 1 час до заражения, эфирные масла добавляли во время адсорбции, либо применяли после адсорбции, на стадии внутриклеточной репликации. Во всех экспериментах в качестве контроля использовались инфицированные, но не обработанные клетки. Предварительная обработка ВПГ эфирными маслами значительно снижала инфекционность вируса — как у чувствительных, так и у устойчивых штаммов.

Эти результаты показывают, что эфирные масла имбиря, тимьяна, иссопа и сандалового дерева воздействуют на вирус до его адсорбции на клетке, а механизм их действия отличается от ацикловира. Даже у устойчивых к ацикловиру клинических штаммов ВПГ-1 образование вирусных колоний значительно уменьшалось.

Эфирные масла наиболее эффективны против внеклеточных вирусов, однако их влияние на внутриклеточную репликацию и распространение вируса от клетки к клетке ограничено. Это свидетельствует о том, что исследуемые эфирные масла могут разрушать или растворять структуру вирусной оболочки (липидной мембраны), необходимой для прикрепления и проникновения вируса в клетку. Электронно-микроскопические исследования также подтвердили разрушение вирусной оболочки после обработки эфирными маслами, что снижало способность вируса заражать клетки.

Кроме указанных эфирных масел, корица также относится к числу растений, противовирусная активность которых была изучена в ряде исследований.

Проведённые эксперименты показали, что кора корицы содержит 21 химическое соединение; 60,41% из них составляет циннамальдегид, а 3,19% эвгенол. Эти вещества обладают антибактериальной активностью против пяти видов бактерий. Кроме того, систематический обзор антибактериальных, противопаразитарных и антиаденовирусных эффектов корицы in vivo и in vitro показал, что корице присущи многочисленные полезные свойства, включая противовоспалительное и антимикробное действие, ускорение заживления ран.

В ходе эксперимента по изучению механизма противовирусного действия корицы был получен гидроалкогольный экстракт корицы методом перколяции. Эксперимент был проведён в условиях in vitro. Для оценки жизнеспособности клеток использовали МТТ-тест (3-(4,5-диметилтиазол-2-ил)-2,5-дифенилтетразолий бромид), а для определения вирусного титра, метод $TCID_{50}$ (50% инфекционная доза для тканевой культуры).

Эффект экстракта оценивался в трёх этапах; до заражения клеток вирусом, одновременно с заражением и после заражения.

На каждом этапе исследовали действие экстракта корицы в концентрациях 1, 0.5 и 0.25 мг/мл. При концентрации экстракта 0.25 мг/мл выживало более 50% клеток. Определение вирусного титра показало вирусную нагрузку 10^5. Было установлено, что экстракт корицы способен снижать вирусный титр при всех исследованных концентрациях.

Поскольку в исследование гидроалкогольный экстракт корицы показало значительное снижение вирусного титра на всех стадиях, особенно на стадии одновременно с заражением вирусом. Эффект гидроалкогольный экстракт корицы может быть обусловлен механизмом, ингибирующим прикрепление ВПГ-1 к клеткам хозяевам. Кроме того, этот эффект экстракта корицы может быть связан с блокированием поверхностных лигандов, отвечающих за связывание вируса с рецепторами на поверхности клетки. Также возможным объяснением является воздействие экстракта на внешнюю оболочку вируса, вызывающее изменения в вирусной оболочке, что может предотвращать прикрепление вируса к клетке и препятствовать заражению клеток. Однако для определения точного механизма действия необходимы дополнительные исследования.

Заключение.

Для лечения герпетических инфекций необходимо искать новые лекарственные средства, поскольку у некоторых штаммов ВПГ существует вирусная резистентность. Несмотря на то, что ацикловир является основным препаратом выбора при лечении поражений, вызванных вирусом простого герпеса, он способен проявлять максимальный противовирусный эффект только в течение первых 72 часов после появления клинических симптомов.Он действует как синтетический аналог нуклеозида и подавляет репликацию вируса путём ингибирования ДНК-полимеразы.

Однако длительное применение ацикловира привело к появлению резизтентных штаммов вируса, что привело к необходимость поиска альтернативных противовирусных средств растительного происхождения. При проведении научных исследований было обнаружено, что эфирные масла и экстракты лекарственных растений проявляют значительную антигерпетическую активность. Растительные экстракты воздействуют преимущественно на липидную оболочку вируса. Незначительное количество инфекионных вирусных частиц, сохранившихся после воздействия эфирных масел, также сохраняло восприимчивость к повторному воздействию. Таким образом, растительные экстракты рассматриваются как перспективной альтернативы синтетическим противовирусным препаратам и могут применяться как самостоятельно, так и в сочетании с ацикловиром для повышения эффективности лечения герпетическич инфекии.

References

1. Andrei G., Balzarini J., Fiten P., Clercq E.D., Opdenakker G., Snoeck R.. Characterization of herpes simplex virus type 1 thymidine kinase mutants selected under a single round of high-dose brivudin. J.Virol, 2005, May;79(9):5863-9. doi:10.1128/JVI.79.9.5863-5869.

2. An T., An J., Gao Y., Li G., Fang H., Song W.. Photocatalytic degradation and mineralization mechanism and toxicity assessment of antivirus drug acyclovir: Experimental and theoretical studies. Applied Catalysis B:Environmental, March

2015;vol.164:279–287. doi:10.1016/j.apcatb.2014.09.009.

3. Astani A., Schnitzler P.. Antiviral activity of monoterpens beta-pinene and limonene against herpes simplex virus in vitro. Iran J Microbiol, 2014 Jun6(3) 149-155. PMCID:PMC4393490, PMID:25870747.

4. Astani A., Reichling J., Schnitzler P.. Comparative study on the antiviral activity of selected monoterpenes derived from essential oils. Phytother Res., 2010, May;24(5):673–679. doi:10.1002/ptr.2955.

5. Astani A., Reichling J., Schnitzler P.. Screening for antiviral activities of isolated compounds from essential oils. Evid Based Complement Alternat Med., 2011. doi:10.1093/ecam/nep187.

6. Bloom D.C.. Alphaherpesvirus Latency:A Dynamic State of Transcriptional and Epigenetic Regulation. Annual Review of Virology, 2016, vol.3;355-374. doi:10.1016/bs.aivir.2015.10.001.

7. Chibo D., Druce J., Sasadeusz J., C.Birch.. Molecular analysis of clinical isolates of acyclovir-resistant herpes simplex virus. Antiviral Res., 2004, Feb;61(2):83-91. doi:10.1016/j.antiviral.2003.08.018.

8. Dahlia Saleh, Siva Naya S., Yarrarapa, Sandeep Sharma.. Herpes simplex type I. August 28, 2023. PMİD:29489260, Bookshelf İD: NBK482197.

9. Erik De Clercq. Antiviral drugs in current clinical use. J Clin Virol, 2004, Jun;30(2):115–133. doi:10.1016/j.jcv.2004.02.009.

10. Gomez L.A., Stashenko E., Ocazionez R.E.. Comparative study on in vitro activities of citral, limonene and essential oils from Lippia citriodora and L.alba on yellow fever virus. Nat Prod Commun., 2013, Feb;8:(2):249–252. PMID:23513741.

11. Huynh T.. Assessment of Traditional Chinese Herbal Medicine Plant Extracts Potential to Inhibit Activity of Herpes Simplex Virus Type 1. Middle Tennessee State University, 2016, p.1-8.

12. Maryam Moshaverinia, Mehrnaz Rastegarfar, Afagh Moattari, Fatemeh Lavaee. Evaluation of the effect of hydro alcoholic extract of cinnamon on herpes simplex virus-1. Dent Res J(Isfahan), 2020, Mar 17;17(2):114-119. PMCID: PMC7224267, PMID:32435433.

13. McLaughlin M.M., Sutton S.H., Jensen A.O., Esterly J.S.. Use of high-dose oral valacyclovir during an intravenous acyclovir shortage:A retrospective analysis of tolerability and drug shortage management. Infect Dis Ther., 2017, Jun;6(2):259–264. doi:10.1007/s40121-017-0157-y.

14. Michael Taylor, Valerie Gerriets. Acyclovir. StatPearls(Internet), 2023, May 7. PMD:31194337, Bookshelf İD:NBK542180.

15. Monavari HR., Hamkar R., Nowrouzbabaie Z., Adibi L., Nowrouz M., Ziyaie A.. The antiviral effects twenty-five different species of medicinal plants in Iran. Iran J Med Microbiol, 2008;1(2):49–59.

16. Moradi MT., Rafieian-Kopaei M., Karimi A.. A review study on the effect of Iranian herbal medicines against in vitro replication of herpes simplex virus. Avicenna J Phytomed, 2016, Sep-Oct;6(5):506–515. PMCID: PMC5052413, PMID:27761420.

17. Morfin F., Souillet G., Bilger K., Ooka T., Aymard M., Thouvenot D.. Genetic characterization of thymidine kinase from acyclovir-resistant and acyclovir-susceptible herpes simplex virus type 1 isolated from bone marrow transplant recipients. J. Infect. Dis., 2000, Jul;182(1):290-293. doi:10.1086/315696.

18. Nicoll MP., Proenca JT., Efstahiou S.. The molecular basis of herpes simplex virus latency. Microbiol Rev., 2012, May;36(3):684-705. doi:10.1111/j.1574-6976.2011.00320.x.

19. Ooi LSM., Li Y., Kam SL., Wang H., Wong EYL., Ooi VEC.. Antimicrobial activities of cinnamon oil and cinnamaldehyde from the Chinese medicinal herb Cinnamomum cassia blume. Am J Chin Med., 2006;34(3):511–22. doi:10.1142/S0192415X06004041.

20. Paul Schintzler, Christine Koch, Jürgen Reichling. Susceptibility of drug-resistant clinical herpes simplex virus type 1 strains to essential oils of ginger, thyme, hyssop and sandalwood. Antimicrob Agents Chemother, 2007, May;51(5):1859-1862. doi:10.1128/AAC.00426-06.

21. Perng GC. , Jones C.. Towards on understanding of the herpes simplex virus type I latency reactivation cycle. Interdiscip Perspect Infect Dis., 2010, 2010:262415. doi:10.1155/2010/262415.

22. Reichling J., Schnitzler P., Suschke U., Saller R.. Essential oils of aromatic plants with antibacterial, antifungal, antiviral, and cytotoxic properties -An overview. Forsch Komplementmed, 2009, Apr;16(2):79–90. doi: 10.1159/000207196.

23 .Reichling, J., Suschke U., Schneele J., Geiss HK.. Antibacterial activity and irritation potential of selected essential oil components-structure-activity relationship. Nat. Prod. Commun., 2019, March1(11):1003-1012. doi: 10.1177/1934578X0600101116.

24. Stranska R., Schuurman R., Nienhuis E., Goedegebuure IW., Polman M., Weel JF.. Survey of acyclovir-resistant herpes simplex virus in the Netherlands: prevalence and characterization. J Clin Virol, 2005, Jan;32(1):7–18. doi: 10.1016/j.jcv.2004.04.002.

25. Vashishtha AK., Kuchta RD.. Effects of acyclovir, foscarnet, and ribonucleotides on herpes simplex virus-1 DNA polymerase:Mechanistic insights and a novel mechanism for preventing stable incorporation of ribonucleotides into DNA. Biochemistry, 2016, Feb23;55(7):1168–77. doi: 10.1021/acs.biochem.6b00065.

26. Whitley RJ., Roizman B.. Herpes simplex virus infections. The Lancet, 2001;357:1513–1518. doi: 10.1016/s0140-6736(00)04638-9.

ECONOMIC SCIENCES

MIDDLE MANAGEMENT ROLE IN IMPLEMENTING QUALITY ASSURANCE STANDARDS IN HIGHER EDUCATION

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Abstract

There is an uncomfortable irony at the heart of quality assurance in higher education: institutions invest substantial effort in designing QA frameworks and training senior leadership to champion them, yet the actual translation of standards into academic practice falls almost entirely to a layer of managers who are routinely overlooked in both research and resource allocation. Department heads, program directors, and academic unit coordinators collectively termed here occupants of academic middle-level positions (OAMLPs) occupy the critical junction between institutional policy and faculty practice. This paper argues that their role is not supplementary but constitutive: without effective middle management engagement, QA standards remain institutional aspirations rather than lived academic realities.

The paper draws on a structured review of empirical literature published between 2020 and 2026, including large-sample quantitative studies (n up to 984), multi-country systematic reviews covering 22 studies across diverse geographic contexts, qualitative case evidence from Tanzania, China, Jordan, Portugal, and the Philippines, and cross-sector management data from Gallup and Prosci. The analysis applies Lipsky's street-level bureaucracy framework alongside identity theory (Dynamic Systems Model of Role Identity) as the principal theoretical lenses.

Across 82% of reviewed studies, department heads and deans were identified as critical facilitators of internal quality assurance engagement. Simultaneously, middle managers in academia face structural conditions, high administrative burden, widening spans of control (now averaging 12.1 direct reports, up from 10.9 in 2024), role conflict, and identity strain, that systematically undermine their capacity to perform this role. The implementation gap between QA policy and departmental practice is most directly explained by failures at the middle management layer, not failures of policy design.

Treating middle managers as passive conduits for top-down QA mandates is an institutional mistake with measurable consequences for accreditation outcomes. A reconceptualization of the OAMLP role from administrator to quality leader requires corresponding investment in training, workload relief, and authority delegation. Institutions that have made this investment show demonstrably better QA implementation outcomes.

Keywords: middle management; quality assurance; department heads; higher education; QA implementation; street-level bureaucracy; role identity; accreditation; OAMLP.

INTRODUCTION

In most published discussions of quality assurance in higher education, two actors dominate the frame: the external accreditation body setting standards and the senior institutional leadership, rectors, vice-chancellors, quality directors responsible for meeting them. What is largely absent from this frame is the person who actually does the work of QA on a daily basis: the head of a chemistry department telling a skeptical colleague why learning outcome mapping matters, the program director negotiating with overloaded faculty to complete self-assessment documentation on time, the academic coordinator trying to make a feedback loop function across a twelve-person teaching team with no additional budget. These are the occupants of academic middle-level positions, and in the existing literature on QA implementation, they are conspicuously undertheorized.

This is not merely an academic observation about a gap in the literature. It has practical consequences. A PRISMA-guided systematic review published in 2025, covering 22 studies of internal quality assurance and stakeholder engagement across diverse national contexts, found that in 82% of those studies, institutional leaders at the department and faculty level, deans and department heads were identified as critical facilitators of QA engagement and strategic decision-making. Put differently: in the vast majority of settings where QA actually works, middle managers are doing something essential. Yet the same literature consistently notes that these actors receive minimal formal preparation for this role, face structural working conditions that make sustained QA engagement difficult, and are rarely the focus of institutional QA improvement strategies.

This paper takes the middle management implementation gap as its central problem. The argument developed here is threefold. First, that the theoretical framing of Lipsky's (1980) street-level bureaucracy long applied to public service workers but underused in higher education management illuminates why the gap between QA policy and practice is an inherent feature of how university governance operates, not an accidental failure of communication. Second, that recent empirical evidence on the identity, workload, and structural position of academic middle managers clarifies the specific mechanisms through which this gap persists. Third, that a set of institutional interventions identifiable from comparative case evidence can meaningfully reduce the gap by repositioning middle managers as genuine quality leaders rather than compliance administrators.

The paper proceeds as follows: Section 2 describes the methodological approach; Section 3 presents empirical findings organized around the structural position, role identity, and implementation behaviors of academic middle managers; Section 4 develops the discussion, including case evidence and practical implications; Section 5 concludes.

METHODS

2.1. Literature Search and Inclusion

This paper employs a structured narrative review approach, integrating findings from across disciplinary streams that rarely speak to each other directly: higher education management, organizational behavior, public administration, and QA policy research. Searches were conducted in Scopus, Web of Science, ERIC, and PubMed Central using term combinations including: ("middle management" OR "department head" OR "program director" OR "academic middle leader") AND ("quality assurance" OR "QA implementation" OR "accreditation standards") AND "higher education." Additional targeted searches retrieved data on academic workload, role conflict, and identity in university management contexts.

Inclusion criteria required that studies address the role, behavior, or structural conditions of middle-level academic managers in relation to QA or institutional quality processes, and that they report primary empirical data or systematic synthesis findings. Studies published before 2018 were included only where they provided foundational theoretical contributions or unique contextual data unavailable in more recent sources. In total, 31 peer-reviewed studies formed the primary evidence base, supplemented by gray literature from Gallup, Prosci, A3ES (Portugal's national QA agency), and national QA reports from Tanzania and the UK.

2.2. Theoretical Framework

Two theoretical frameworks anchor the analysis. The first is Lipsky's (1980) concept of street-level bureaucracy, which describes frontline public workers who exercise significant discretion in implementing policy, discretion that fundamentally shapes what policy becomes in practice. Applied to academic middle managers, this framework predicts that QA standards will be enacted differently across departments not because of institutional miscommunication but because OAMLPs necessarily adapt policy to local conditions, priorities, and constraints. Understanding this discretion as a structural feature rather than a compliance failure reframes the management challenge entirely.

The second framework is the Dynamic Systems Model of Role Identity (DSMRI), applied to academic department heads by Ghamrawi (2025) in a study published in Higher Education Quarterly. This model treats identity not as a fixed attribute but as a dynamic, context-sensitive construction that shifts in response to institutional demands, interpersonal relationships, and personal values. When the identity demands of a senior administrator ("implement this QA framework") collide with the identity demands of a peer academic ("don't burden colleagues with paperwork"), the middle manager experiences identity strain and their QA implementation behavior is shaped by how they navigate it.

3. RESULTS

3.1. The Structural Position of the Academic Middle Manager

To understand why QA implementation falters at the middle management layer, it is necessary to first appreciate the structural conditions under which OAMLPs operate. These are not, in most institutions, managers in any robust sense of the term. They are typically academics who have been appointed, often reluctantly to an administrative role they will hold for a defined term before returning to full-time research and teaching. They generally lack formal management training. Their authority over faculty is heavily constrained by collegial norms that make direct performance management culturally fraught. And they bear responsibility for QA outcomes without commensurate control over the resources, time, staffing, budget needed to achieve them.

The workload picture is particularly striking. Cross-sector data from Gallup (2025), drawing on Bureau of Labor Statistics figures, documents that the average span of control for managers increased from 10.9 direct reports in 2024 to 12.1 in 2025 a 50% increase since 2013. In higher education, this span of control problem is compounded by the nature of academic work: unlike most organizational contexts, faculty cannot simply be directed to comply with administrative requirements. Their professional autonomy is a genuine structural feature of the institution, not an attitude problem. A study by Al-Zoubi et al. (2024), surveying 205 faculty members across universities in Jordan and the UAE, found that department heads were perceived as facing high levels of work pressure while simultaneously maintaining high decision-making effectiveness, a combination that suggests significant personal cost to the individuals in these roles.

This burden is documented not just in perception surveys but in behavioral data. A 2024 study by Gou and Shen, using multi-source paired data from 60 department chairs and 250 faculty members across 10–14 Chinese universities undergoing reform, found that department chairs face the compounded challenge of balancing administrative duties with academic mentorship, and that their ability to maintain effective faculty relationships, which directly predicts faculty quality engagement degrades under high administrative load. The implications for QA are direct: a department head managing twelve faculty, running a research program, and coordinating curriculum reviews has limited bandwidth for the sustained relational work that quality culture requires.

3.2. Role Identity and the Implementation Dilemma

The structural picture above would suggest that OAMLPs are simply overwhelmed, that the solution is primarily one of workload reduction. But the evidence reveals a more complex dynamic. Ghamrawi's 2025 qualitative study, applying the DSMRI framework to department heads in higher education, documents that the core challenge for OAMLPs is not merely busyness but identity conflict. Department heads simultaneously inhabit at least three identity positions: researcher/scholar (their primary professional identity), collegial peer (equal among faculty colleagues), and

manager/administrator (the role assigned by the institution). These identities pull in different directions when QA implementation is at stake.

When an institutional QA directive requires a department head to enforce documentation standards on colleagues who view such requirements as bureaucratic intrusion, the peer identity and the manager identity are in direct conflict. Faculty who have served with colleagues for years, who share research interests, co-author papers, serve on the same committees, find it genuinely uncomfortable to adopt an evaluative or compliance-enforcing posture toward those same colleagues. The DSMRI framework describes this as a "dynamic tension" that shapes behavior in ways that are neither purely compliant nor purely resistant, but adaptive and contextual. In practice, this often means that QA standards are implemented selectively: requirements perceived as professionally legitimate are advanced with energy, while those perceived as administrative theater are quietly deprioritized.

This is precisely the discretion that Lipsky's framework predicts. Academic middle managers are not passive transmission mechanisms for institutional policy; they are active interpreters of it, and their interpretive choices have significant consequences for what QA standards actually mean at the program level. A study by Li and Zhang (2024), drawing on 27 semi-structured interviews across a Sino-Foreign Cooperative University, conceptualizes this as the "translucent hand" of middle management, neither the invisible hand of pure market coordination nor the visible hand of directive authority, but a partly opaque influence that shapes outcomes through both explicit decisions and implicit cultural signaling.

3.3. Evidence on Implementation Outcomes

What does this structural and identity analysis predict about QA implementation outcomes and does the empirical record confirm it? The available evidence supports a consistent pattern: QA frameworks that rely primarily on top-down compliance mechanisms without genuine middle management engagement produce documentation without culture, process without improvement.

A 2025 study examining QA system implementation in Tanzanian universities found that QA policies were formally in place across institutions but that effectiveness varied sharply depending on department-level engagement. The study noted that QA manuals developed between 2013 and 2014 largely by senior academic staff had limited operational input from those expected to implement them, creating a gap between policy intent and departmental practice that persisted more than a decade later. Faculty and department-level staff reported that QA activities were carried out primarily to satisfy external requirements rather than to drive genuine improvement.

The Portuguese case offers a more optimistic counterpoint. Fialho et al. (2025), in a national study spanning 984 academics across all public and private HEIs in Portugal, found that management support was the strongest predictor of QA system effectiveness ($\beta = 0.62$, $p < 0.001$). The second cycle of institutional evaluation by A3ES, completed in 2024, documented measurable progress specifically in institutions where quality structures had been strengthened and accountability had been made more visible. While the study does not isolate middle management as a distinct variable, a methodological limitation acknowledged by the authors, the finding that management support at all levels drives QA effectiveness is consistent with the interpretation that middle managers, as the primary management interface between institutional leadership and faculty, are a critical channel for this effect.

Table 1.

Summary of key empirical findings on middle management and QA implementation (2020–2026)

Study	Context / Sample	Key Finding	Middle Mgmt Variable	Outcome
Fialho et al. (2025)	Portugal; n=984 academics	Management support strongest predictor of QAS effectiveness	Institutional management support	β=0.62***
PRISMA review (2025)	Global South; 22 studies	82% of studies: dept heads critical for QA engagement	Dept heads, deans	82% of studies confirm
Ghamrawi (2025)	HEI qualitative study; dept heads	OAMLP identity conflicts shape selective QA implementation	Role identity strain	Qualitative
Gou & Shen (2026)	China; 60 chairs + 250 faculty, 10–14 universities	Chair leadership identity positively predicts faculty QA thriving	Dept chair leadership identity	HLM positive
Al-Zoubi et al. (2024)	Jordan/UAE; n=205 faculty	Dept heads: high work pressure, high effectiveness unsustainable	Work pressure on decision-making	Correlational
Li & Zhang (2024)	Sino-Foreign Univ; 27 interviews	Middle mgrs act as 'translucent hand': mediate top-down + bottom-up	Collaboration role typology	Grounded theory
Tanzania QA study (2025)	Multi-university mixed-methods	QA policy-practice gap persists where dept-level engagement absent	Dept-level implementation fidelity	Gap documented

Note: $p < 0.001$; HLM = Hierarchical Linear Modelling; OAMLP = Occupant of Academic Middle-Level Position.

Perhaps the most direct evidence comes from a PRISMA-guided systematic review of internal QA and stakeholder engagement across 22 studies with a Global South focus. The review found that in 15 of those studies (68%), active stakeholder participation in

quality assurance committees and peer review of teaching was associated with stronger ownership and responsibility for quality outcomes. The role of institutional leaders at department level was specifically identified as critical in this regard. Of equal significance: the review identified faculty resistance and insufficient communication as the primary barriers to QA effectiveness, both of which are conditions that middle managers are uniquely positioned to address or exacerbate.

4. DISCUSSION

4.1. The Policy-Practice Gap as a Management Problem

The evidence reviewed here points toward an uncomfortable conclusion for QA administrators: the implementation gap that plagues so many quality reform efforts is not primarily a problem of policy quality, communication strategy, or faculty culture. It is a management problem, specifically, a problem located in the structural and identity conditions of the people tasked with making policy real at the program level.

Lipsky's insight is still relevant here more than four decades after he articulated it: when complex policy meets resource-constrained, discretion-exercising frontline workers, the policy is inevitably reshaped. The question for institutional management is not whether academic middle managers will exercise discretion over QA implementation, they will, because the conditions of their role make it unavoidable, but whether that discretion will be exercised in ways that advance or undermine quality goals. That depends, in turn, on the organizational conditions surrounding the OAMLP: their understanding of quality goals, their sense of personal investment in quality outcomes, the organizational support they receive, and the authority they have to act.

Three institutional failure modes are discernible from the evidence. The first is the mandate-without-authority failure: QA requirements are imposed on departments without giving department heads the authority, over workload allocation, curriculum decisions, peer review processes, needed to implement them. The second is the training-without-support failure: department heads receive information about new QA systems but no reduction in existing administrative responsibilities, no additional staffing, and no peer network of QA-engaged middle managers to draw on. The third, and perhaps most insidious, is the identity-without-acknowledgment failure: institutions ask department heads to exercise managerial authority over QA but never explicitly acknowledge or support this aspect of their role, leaving identity strain unaddressed and peer-relationship conflicts unresolved.

4.2. What Effective Middle Management QA Looks Like: Cases

Against this landscape of failure modes, several case contexts illuminate what effective middle management engagement in QA actually involves.

The Portuguese higher education system, following reforms driven by A3ES and aligned with the European Standards and Guidelines (ESG 2015), provides perhaps the best-documented example of systemic progress. The second evaluation cycle completed in 2024 identified institutional accountability and strengthened quality structures as the primary drivers of improvement. Crucially, this improvement was not achieved by redesigning top-level governance alone but by making quality a visible, resourced responsibility at the faculty and department level, what the A3ES framework terms "quality ownership" at the proximal level of academic delivery. Institutions in Portugal that demonstrated measurable QA progress were those where faculty development, management training, and clear role delineation for department-level QA responsibility had been most explicitly pursued.

In the Chinese context, Gou and Shen's (2026) multilevel study of universities undergoing comprehensive reform provides granular evidence of the mechanism. Using hierarchical linear modelling across paired chair-faculty data, they found that a department chair's leadership identity, specifically, the degree to which chairs had internalized a quality-oriented leadership self-concept, positively predicted faculty psychological empowerment and, through it, faculty engagement with reform processes. The moderation by work arrangement flexibility is also instructive: the positive effects of leadership identity on empowerment were significantly stronger when working conditions allowed chairs to adapt how and when they engaged with faculty. This is indirect evidence that structural flexibility giving department heads room to do relational quality work in ways that fit their context matters as much as any formal QA training program.

The Tanzanian case provides the cautionary counterpoint. Where QA manuals were developed without meaningful department-level input, where implementation responsibility was delegated to QA units rather than embedded in departmental management roles, and where no sustained investment was made in building department-level QA competency, the policy-practice gap persisted across more than a decade. External compliance metrics improved; internal quality culture did not.

4.3. Implications for Institutional Practice

What follows from this analysis for institutions serious about QA implementation, not just accreditation compliance, but the substantive quality of learning and teaching that QA exists to protect? Four implications stand out.

As long as department heads are understood by themselves, their colleagues, and the institution primarily as senior academics temporarily burdened with administrative duties, QA implementation will be treated as a peripheral responsibility. Institutions need to formally recognize the quality leadership function as a core dimension of the department head role, articulate what it involves in practice, and communicate that recognition publicly. This is not merely symbolic: it affects hiring criteria, performance review frameworks, and how OAMLPs understand their own authority.

The most consistent finding across implementation studies is that training and capability development in QA is directed at either senior leaders or faculty rarely at the middle managers who must work the seam between them. Dedicated programs that build QA knowledge, change management skills, and the capacity to have difficult conversations about quality stand-

ards with peer colleagues are a largely untapped intervention. The evidence from the Portuguese and Chinese cases suggests this investment has measurable returns.

Asking department heads to lead QA implementation while maintaining full research and teaching commitments, managing a growing number of direct reports, and handling expanding administrative tasks is a recipe for identity strain and burnout. Gallup data indicating that 45–75% of middle managers across sectors report burnout is a warning that higher education cannot afford to ignore. Workload relief reduced teaching loads, administrative support, time allocation specifically for QA activities is not a luxury but a prerequisite for sustained middle management QA effectiveness.

One structural advantage that higher education institutions have, and rarely exploit for QA purposes, is the lateral density of middle managers dozens or hundreds of department heads who face similar implementation challenges. Creating communities of practice around QA implementation, where department heads share approaches, troubleshoot problems, and develop shared norms of quality leadership, addresses both the competency gap and the identity isolation that makes the role so difficult. It also builds the distributed quality culture that no centralized QA unit can create alone.

5. CONCLUSION

Quality assurance in higher education will continue to improve on paper faster than it improves in practice until institutions reckon honestly with where implementation actually happens and who is responsible for it. The evidence reviewed in this paper makes the case, across multiple national contexts and methodological traditions, that middle managers are the linchpin of QA implementation: they are identified as critical in the vast majority of effectiveness studies, they exercise genuine and consequential discretion over how standards are enacted at the program level, and they do this work in structural conditions that systematically undermine their capacity to do it well.

None of this is to suggest that senior leadership or QA policy design are unimportant. The strength of institutional management support demonstrated with a path coefficient of $\beta = 0.62$ in the most comprehensive quantitative study to date is real and significant. But management support that does not translate into department-level action is support for a policy, not for quality. The translation layer is middle management, and it deserves dedicated institutional investment.

Three things would most advance the research agenda in this area. First, longitudinal studies tracking QA culture development in relation to deliberate middle management investment would allow causal inference that cross-sectional studies cannot support. Second, comparative evidence from transitional higher education systems particularly in Central Asia, the Caucasus, and sub-Saharan Africa, where QA infrastructure is relatively new and middle management capacity is often weakest is both practically urgent and empirically underrepresented. Third, the OAMLP identity literature deserves integration with QA implementation research: understanding how department heads' self-concepts shape their quality behaviors is a richer theoretical framework than the compliance/resistance binary that dominates most QA management thinking.

The forgotten layer is not forgotten because it is unimportant. It is forgotten because the people in it tend not to write about their own experience they are too busy trying to implement quality standards with inadequate authority, insufficient training, and a persistent sense that the institution's formal attention is directed both above and below them. Directing more of that attention toward them is, the evidence suggests, among the highest-return investments a university serious about quality can make.

References

1. A3ES. (2024). Second institutional evaluation cycle: Summary of findings. Agência de Avaliação e Acreditação do Ensino Superior, Lisbon.

2. Ahmad, A., & Rizvi, S. (2025). Stakeholder engagement and internal quality assurance in South Asian universities. Quality in Higher Education, 31(1), 45–62.

3. Al-Zoubi, Z., AlKaabi, A., Qablan, A., & Bataineh, O. (2024). The impact of work pressure on decision-making effectiveness among department heads in faculties of educational sciences. PLOS ONE, 19(8), e0304584.

4. Fialho, A., et al. (2025). Determinants of the effectiveness of quality assurance systems and institutional performance in higher education. Cogent Education, 12(1), Article 2581411.

5. Gallup. (2025). State of the Global Workplace 2025. Gallup Inc.

6. Ghamrawi, N. (2025). Leading or managing in the middle: Exploring the identities of heads of departments in higher education using the Dynamic Systems Model. Higher Education Quarterly, e70037.

7. Gou, J., & Shen, Y. (2026). The impact of department chair leadership identity on faculty thriving in comprehensive university reform: The cross-level moderating role of work arrangement flexibility. Frontiers in Psychology, 16, Article 1722813.

8. Graham, C., et al. (2023). Faculty participation in quality assurance governance: Ownership, resistance, and the middle management nexus. Assessment & Evaluation in Higher Education, 48(4), 502–517.

9. Li, J., & Zhang, X. (2024). Role of middle managers in dealing with hierarchy and network logics: Exploration in the context of Sino-Foreign Cooperative University. Frontiers in Psychology, 14, Article 1328675.

10. Lipsky, M. (1980). Street-Level Bureaucracy: Dilemmas of the Individual in Public Services. New York: Russell Sage Foundation.

11. Maddock, L. (2023). Occupants of academic middle-level positions: Role construction and the limits of distributed leadership. Studies in Higher Education, 48(9), 1340–1354.

12. PRISMA Review. (2025). A PRISMA-guided systematic review of internal quality assurance and stakeholder engagement in higher education: Beyond accreditation with a focus on the Global South. European Journal of Educational Research, 14(2), 665–683.

13. Prosci. (2023). Best Practices in Change Management: 12th Edition. Prosci Inc., Fort Collins, CO.

14. Tanzania QA Study. (2025). Exploring factors for the introduction and implementation of quality assurance systems in selected higher education institutions in Tanzania. Cogent Education, 12(1), Article 2455767.

15. Warta, K., et al. (2023). Quality committees and peer review structures: Middle management as the connective tissue of internal QA. Quality in Higher Education, 29(3), 289–305.

ANALYSIS OF THE CORPORATE GOVERNANCE SYSTEM IN THE BANKING SECTOR OF UZBEKISTAN

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Abstract
The article examines the impact of corporate governance factors on the financial performance of commercial banks in Uzbekistan. The empirical base includes data from 12 banks for 2024. Return on equity is used as the dependent variable. The explanatory variables include state ownership, board characteristics, independent directors, committees, gender diversity, market discipline, disclosure level and ESG integration. The results confirm a strong negative relationship between state ownership and ROE, while market discipline and disclosure have a positive effect on financial performance. The regression model explains 89.85 percent of ROE variation.
Keywords: corporate governance, banking sector, state ownership, ROE, disclosure, market discipline, ESG, regression analysis, Uzbekistan.

Introduction

The banking sector of Uzbekistan is one of the most illustrative areas for analyzing corporate governance in state-owned enterprises. Banks accumulate significant financial resources, participate in government programs, provide lending to priority sectors, and foster trust in the financial system. Moreover, the level of corporate governance at banks affects not only their internal stability but also their investment attractiveness, the quality of capital allocation, and the transparency of state asset use.

State-owned banks have a dual nature. On the one hand, they must ensure profitability of capital, maintain capital adequacy, reduce problem loans, and improve operational efficiency. On the other hand, they participate in funding government programs, supporting the population and businesses, implementing socioeconomic objectives, and ensuring the stability of individual industries. This specificity complicates the corporate governance system and increases the importance of transparency, independent control, and market discipline.

In this study, corporate governance is considered not as a formal set of governance bodies, but as a set of factors that can influence a bank's financial performance. These factors include ownership structure, supervisory board activity, the presence of independent directors, committee work, information disclosure, ESG integration, and market discipline.

The purpose of this article is to quantitatively assess the impact of corporate governance factors on the return on equity of commercial banks in Uzbekistan.

The research hypothesis is that banks' ROE depends not only on financial and operational characteristics but also on the quality of corporate governance, ownership structure, transparency, and the bank's degree of engagement in market mechanisms.

Literature Review

The theoretical basis of the study is agency theory, according to which corporate governance aims to reduce conflict between owners and management. M. Jensen and W. Meckling viewed agency costs as a consequence of the misalignment of interests between owners and managers. Control mechanisms, incentive systems, information disclosure, and a supervisory board are used to reduce them.

A. Shleifer and R. Vishny linked corporate governance with investor protection mechanisms and ensuring a return on invested capital. In the banking sector, this problem becomes more complex, since a bank manages not only shareholders' capital but also the funds of depositors, creditors, and other participants in the financial system.

For banks with state participation, the agency problem is complicated by the role of the state. The state acts not only as a shareholder but also as a regulator, guarantor of financial stability, and bearer of public interests. This can lead to multiple objectives, reduced market discipline, and administrative influence on management decisions. International corporate governance practices place particular emphasis on information disclosure, board independence, internal audit, risk management, and shareholder protection. The OECD principles view governance transparency and accountability as fundamental to enhancing investor confidence and corporate sustainability.

ESG approaches expand the traditional understanding of corporate governance. For banks, ESG is not only important for reputational reasons. It is linked to risk management, sustainable financing, transparency, internal control, and the quality of strategic decisions. However, in the Uzbek banking sector, ESG integration is still in its infancy, so its impact on financial performance requires a separate empirical assessment.

Materials and Methods

The empirical basis of the study includes data from 12 commercial banks in Uzbekistan for 2024. The sample includes banks with various ownership structures: banks with 100% state participation, banks with a high state shareholding, banks with a mixed ownership structure, and private banks. This approach allows us to compare the impact of state participation, transparency, and market discipline on financial performance.

Table 1

Calculation of ROA and ROE of banks for 2024

Bank	Assets at the end of 2023, billion soums	Assets at the end of 2024, billion soums	Average assets, billion soums	Net profit 2024, billion soums	ROA, %	ROE, %
Agrobank	79 403.83	66 699.71	73 051.77	750.89	1.03	6.07
Aloqabank	16 044.65	23 251.27	19 647.96	189.97	0.97	6.64
Asakabank	58 014.44	58 092.91	58 053.67	41.58	0.07	0.57
Kapitalbank	41 865.90	47 364.69	44 615.29	1 155.90	2.59	24.46
O‘zmilliybank	127 502.89	135 089.96	131 296.42	1 722.20	1.31	9.38
Xalq Banki	36 602.78	46 490.87	41 546.83	268.55	0.65	3.36

Return on equity (ROE) was chosen as the dependent variable. This indicator reflects the efficiency of shareholder capital utilization and is a key performance indicator for banks.

The following were used as independent variables:

STATE_OWNERSHIP - government stake in the bank's capital, %

BOARD_SIZE - number of supervisory board members;

Indep_dr - number of independent directors;

Committees - number of supervisory board committees;

Women_pct - proportion of women on the supervisory board;

P/BV - market discipline indicator;

DISCLOSURE - disclosure index on a scale of 1 to 5;

ESG - ESG integration indicator on a scale of 1 to 5.

The research methodology includes two stages. In the first stage, the Pearson and Spearman correlation coefficients were calculated to identify the direction and strength of the relationship between ROE and corporate governance factors. In the second stage, a multiple regression model was constructed, which included the most significant factors: the share of state participation, the market discipline indicator, and the level of information disclosure.

Results

The initial data reveal significant differences between banks in terms of ROE, government ownership, and corporate governance parameters.

Table 2

Initial data for the econometric analysis of local banks for 2024

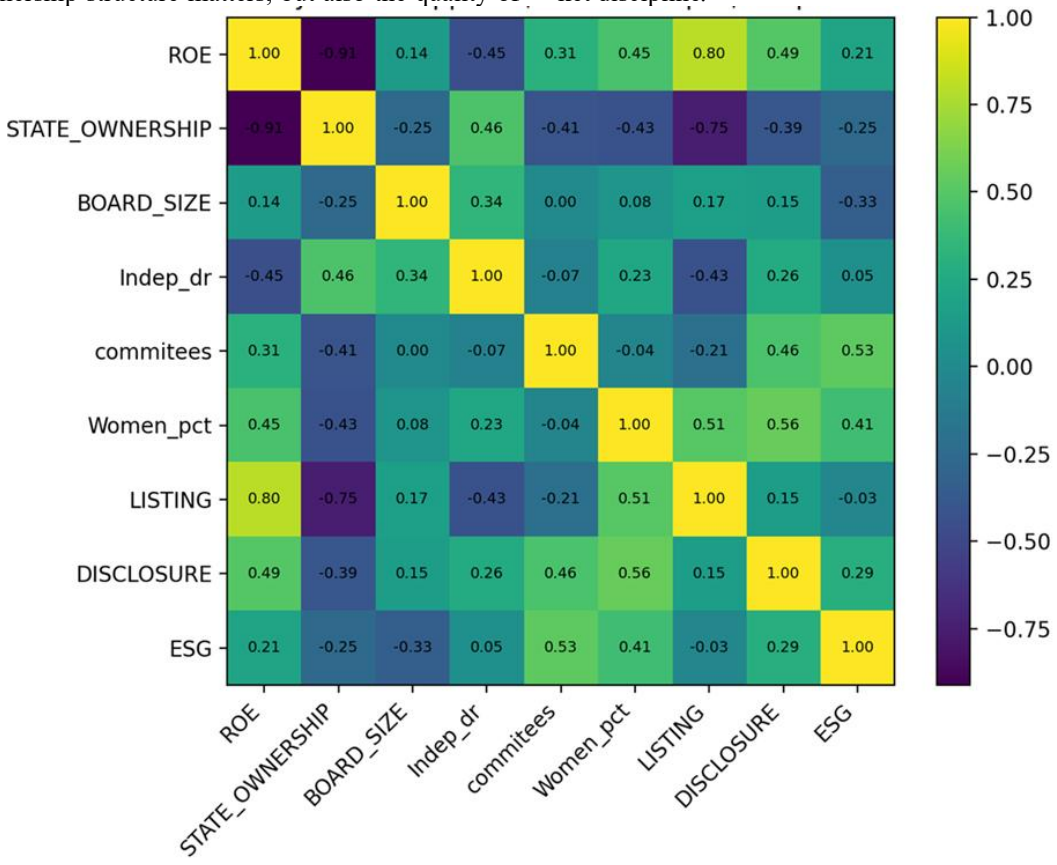
Bank	ROE, %	State ownership, %	Board members.	Independent directors	Commitees	Female in the board	P/BV	Disclosure	ESG
Xalq Banki	3,36	100,0	7	2	5	0,14	0,00	4,0	3,5
O‘zmilliybank	9,13	100,0	7	4	5	0,14	0,00	4,5	4,0
Agrobank ATB	0,56	99,0	9	3	4	0,00	0,53	3,0	3,5
Asakabank	0,52	99,2	9	5	4	0,22	0,00	3,0	3,0
Ipoteka-bank	10,81	24,54	9	5	6	0,33	3,47	5,0	5,0
Aloqabank	6,16	84,0	11	5	5	0,09	0,85	4,5	2,0
Kapitalbank ATB	22,12	0,0	9	2	7	0,14	1,08	4,5	5,0
SQB	10,45	96,0	9	6	5	0,33	1,67	5,0	5,0
Turonbank ATB	1,21	98,7	9	4	5	0,11	0,63	3,0	4,0
Mikrokreditbank ATB	1,04	99,5	8	3	5	0,00	0,99	2,0	4,0
HAMKORBANK	27,64	0,0	9	2	5	0,11	11,28	4,0	3,0
IPAK YO‘LI AITB	25,38	0,0	9	2	4	0,44	14,30	4,0	4,0

Source: compiled by the author based on the banks' annual reports, disclosure data, and the author's calculations.

The highest ROE is observed among banks without state participation. Hamkorbank demonstrated an ROE of 27.64%, AITB Ipak Yo'li - 25.38%, and Kapitalbank ATB - 22.12%. Among banks with a high percentage of state participation, lower values were observed at Asakabank (0.52%), Agrobank ATB (0.56%), Mikrokreditbank ATB (1.04%), and Turonbank ATB (1.21%).

However, the presence of a state stake does not always mean low performance. For example, O'zmilliybank, with 100% state participation, has an ROE of 9.13%, while SQB, with a 96% state participation, has

an ROE of 10.45%. This demonstrates that not only theownership structure matters, but also the quality of corporate governance, information disclosure, and market discipline.



Picture 1. Pearson correlation matrix

The strongest negative correlation was found between STATE_OWNERSHIP and ROE. The Pearson coefficient was -0.9114, while the Spearman coefficient was -0.7478. This indicates a strong inverse relationship between state ownership and return on equity.

The P/BV ratio demonstrated a strong positive correlation with ROE: the Pearson coefficient was 0.8008, while the Spearman coefficient was 0.7747. This result suggests that market discipline is a factor associated with higher financial performance of banks.

DISCLOSURE also showed a positive correlation with ROE. The Pearson coefficient was 0.4933, while the Spearman coefficient was 0.6263. The rank correlation is statistically significant, confirming the importance of disclosure in improving capital efficiency.

The ESG indicator has a positive, but weak, correlation with ROE. The Pearson coefficient was 0.2067. This result reflects the early stage of ESG integration in the banking sector of Uzbekistan.

Table 3

Multiple regression results:
ROE ~ STATE_OWNERSHIP + P/BV + DISCLOSURE

Parameter	Coefficient	Std. Error	t-statistics	p-value	p-value (HC3)
Constanta	7.1546	7.5638	0.9459	0.3719	0.7011
STATE_OWNERSHIP	-0.1253	0.0417	-3.0066	0.0169	0.4152
P/BV	0.7061	0.3698	1.9094	0.0926	0.5567
DISCLOSURE	2.3289	1.3493	1.726	0.1226	0.1812

$$ROE_i = 7{,}1546 - 0{,}1253 \cdot STATE_OWNERSHIP_i + 0{,}7061 \cdot P/BV_i + 2{,}3289 \cdot DISCLOSURE_i$$

To quantitatively test these relationships, the dissertation constructs a multiple regression model explaining variations in ROE. The resulting value of the determination coefficient, $R^2 = 0.8985$, demonstrates the model's high explanatory power. According to the resulting model, an increase in government participation by 1 percentage point is accompanied by a decrease in ROE by an average of 0.1253 percentage points. At the same time, an increase in the P/BV (market discipline) ratio by 1 unit leads to an increase in ROE by an average of 0.7061 percentage points, and an increase in the disclosure index by 1 point is associated with an increase in ROE by 2.3289 percentage points. The model's determination coefficient is 0.8985, demonstrating the high explanatory power of the included factors.

Table 4

Diagnostic indicators of the final model

Diagnostic indicator	Meaning
R^2	0.8985
Adjusted R^2	0.8604
p-value F-test	0.0003
Durbin-Watson	1.7522
Shapiro-Wilk W (остатки)	0.8855
Shapiro-Wilk p-value (остатки)	0.1032
Breusch-Pagan p-value	0.1663
RESET p-value	0.7641

This means that the corporate governance factors included in the model largely explain the differences in return on equity between the studied banks. Thus, in the second chapter, we empirically confirmed the dependence of banks' financial performance on the quality of corporate governance, the level of transparency, and the degree of market discipline.

To verify the robustness of the model, diagnostic tests were used. The VIF values for the independent variables were below the threshold of 5, confirming the absence of critical multicollinearity. The Breusch-Pagan test revealed no statistically significant heteroscedasticity, the Shapiro-Wilk test confirmed the acceptability of the residual distribution, and the RESET test revealed no errors in the functional form of the model.

Thus, it has been empirically confirmed that the financial performance of state-owned banks depends not only on their internal financial characteristics but also on the quality of corporate governance. The most significant factors are ownership structure, the level of market discipline, and the transparency of information disclosure. The obtained results confirm the second scientific novelty of the dissertation and substantiate the need to further enhance transparency, develop market discipline, and reduce banks' excessive dependence on state participation.

Discussion

The study results confirm that ownership structure is significantly related to bank financial performance. A high state stake is associated with lower return on equity. This result can be explained by state-owned banks' participation in socio-economic development programs, lower pressure from private investors, administrative influence, and weak market discipline.

However, the negative relationship between state ownership and ROE should not be interpreted as automatic evidence of the inefficiency of all state-owned banks. Some banks with a high state stake demonstrate acceptable ROE values. This indicates that the quality of the state's ownership role, as well as the level of transparency, control, and market discipline, are key factors.

A positive relationship between P/BV and ROE demonstrates that market discipline is a significant factor in financial performance. If a bank is subject to market valuation, interacts with investors, and discloses information, the demands on governance quality become higher. This creates additional pressure on management and the supervisory board.

The level of information disclosure is also associated with higher ROE. For banks with state participation, transparency serves a dual function. It reduces information asymmetry for investors and creditors and ensures public oversight of the use of state assets. The higher the quality of information disclosure, the lower the uncertainty regarding the bank's financial condition and the quality of management decisions.

The ESG indicator showed a positive, albeit weak, correlation with ROE. This is explained by the fact that ESG practices in the Uzbek banking sector are not yet fully integrated into strategy, KPIs, and the management performance assessment system. In most cases, ESG disclosure is fragmented, so its impact on financial performance is limited.

The practical significance of these results lies in the fact that improving the efficiency of state-owned banks requires more than just financial measures. Institutional changes are also necessary: increased transparency, development of listings, a stronger role for supervisory boards, an increased proportion of independent directors, expanded disclosure, and a transition from formal ESG to ESG-based KPIs.

Conclusion

An empirical analysis of 12 commercial banks in Uzbekistan for 2024 confirmed the existence of a connection between the quality of corporate governance and the financial performance of banks. The strongest negative relationship was found between the share of government participation and ROE. At the same time, the positive impact of market discipline and the level of information disclosure was established.

The constructed multiple regression model has a high explanatory power. $R^2 = 0.8985$ shows that the included factors explain a significant portion of the variation in the return on equity of the studied banks.

According to the model results, a one percentage point increase in government ownership is associated with a 0.1253 percentage point decrease in ROE. A one-unit increase in market discipline is associated with a 0.7061 percentage point increase in ROE. A one point increase in the disclosure index is associated with an increase in ROE of 2.3289 percentage points.

The results obtained allow us to consider corporate governance as an independent factor in the financial efficiency of banks. For the banking sector of Uzbekistan, priority areas should be increasing transparency, strengthening market discipline, professionalizing supervisory boards, developing listings and integrating ESG indicators into the system of strategic KPIs.

References

1. Jensen M.C., Meckling W.H. Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure // Journal of Financial Economics. 1976. Vol. 3. No. 4. P. 305–360. DOI: 10.1016/0304-405X(76)90026-X.

2. Shleifer A., Vishny R.W. A Survey of Corporate Governance // The Journal of Finance. 1997. Vol. 52. No. 2. P. 737–783. DOI: 10.1111/j.1540-6261.1997.tb04820.x.

3. La Porta R., Lopez-de-Silanes F., Shleifer A., Vishny R.W. Investor Protection and Corporate Governance // Journal of Financial Economics. 2000. Vol. 58. No. 1–2. P. 3–27. DOI: 10.1016/S0304-405X(00)00065-9.

4. OECD. G20/OECD Principles of Corporate Governance 2023. Paris: OECD Publishing, 2023.

5. OECD. OECD Guidelines on Corporate Governance of State-Owned Enterprises 2024. Paris: OECD Publishing, 2024.

6. Tricker B. Corporate Governance: Principles, Policies, and Practices. 3rd ed. Oxford: Oxford University Press, 2015. 550 p.

7. Cadbury A. Report of the Committee on the Financial Aspects of Corporate Governance. London: Gee and Co. Ltd., 1992. 90 p.

8. Freeman R.E. Strategic Management: A Stakeholder Approach. Boston: Pitman, 1984. 276 p.

9. Кодекс корпоративного управления Республики Узбекистан. Утвержден протоколом заседания Комиссии по повышению эффективности деятельности акционерных обществ и совершенствованию системы корпоративного управления от 31 декабря 2015 г. № 9.

10. Закон Республики Узбекистан «Об акционерных обществах и защите прав акционеров» от 6 мая 2014 г. № ЗРУ-370.

11. Постановление Кабинета Министров Республики Узбекистан от 29 марта 2021 г. № 166 «Об утверждении Стратегии управления и реформирования предприятий с государственным участием на 2021–2025 годы».

12. Указ Президента Республики Узбекистан от 27 октября 2020 г. № УП-6096 «О мерах по ускоренному реформированию предприятий с участием государства и приватизации государственных активов».

13. Указ Президента Республики Узбекистан от 28 января 2022 г. № УП-60 «О Стратегии развития Нового Узбекистана на 2022–2026 годы».

14. Годовые отчеты и финансовая отчетность коммерческих банков Узбекистана за 2024 год.

15. Данные Единого портала корпоративной информации Республики Узбекистан за 2024 год.

PEDAGOGICAL SCIENCES

РУКОВОДСТВО ШКОЛОЙ И ЛИДЕРСКИЙ ПОТЕНЦИАЛ УЧИТЕЛЕЙ: СРАВНИТЕЛЬНОЕ ИССЛЕДОВАНИЕ РАЗЛИЧНЫХ ТИПОВ ШКОЛ. КАК ШКОЛЬНОЕ РУКОВОДСТВО РАЗВИВАЕТ ЛИДЕРСКИЙ ПОТЕНЦИАЛ УЧИТЕЛЕЙ: МНЕНИЯ КАЗАХСТАНСКИХ ПЕДАГОГОВ

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SCHOOL LEADERSHIP AND TEACHERS' LEADERSHIP POTENTIAL: A COMPARATIVE STUDY OF DIFFERENT TYPES OF SCHOOLS. HOW SCHOOL LEADERSHIP DEVELOPS TEACHERS' LEADERSHIP POTENTIAL: PERSPECTIVES OF KAZAKHSTANI TEACHERS

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Аннотация

В статье рассматривается лидерский потенциал педагогического коллектива как один из ключевых ресурсов современного развития образовательной организации. Обосновывается значимость перехода от традиционного понимания лидерства к концепции распределенного лидерства. Проанализированы основные подходы к трактовке понятия «лидерства», а также раскрыта их природа. Особое внимание уделено влиянию различных стилей руководства (авторитарного, демократического и либерального) на формирование и развитие лидерского потенциала педагогического коллектива. Представлена структура лидерского потенциала, включающая ключевые личностные качества и факторы роста педагогов. На основе проведенного исследования и сравнительного анализа стилей управления в гимназиях, специализированных и общеобразовательных школах выявлены уровни проявления лидерских способностей педагогов. Результаты исследований показывают, что наиболее благоприятные условия для развития лидерского потенциала формируются при демократическом и либерально-демократическом стиле руководства, которые способствуют развитию инициативы, ответственности и профессиональной автономии педагогов.

Abstract

The article examines the leadership potential of a teaching staff as one of the key resources for the modern development of an educational organization. It substantiates the importance of shifting from a traditional understanding of leadership to the concept of distributed leadership. The main approaches to interpreting the concept of “leadership” are analyzed, and their nature is explored. Particular attention is paid to the influence of different leadership styles (authoritarian, democratic, and laissez-faire) on the formation and development of the leadership potential of a teaching staff. The structure of leadership potential is presented, including key personal qualities and growth factors of teachers. Based on the conducted research and a comparative analysis of management styles in gymnasiums, specialized schools, and general education schools, the levels of teachers’ leadership abilities are identified. The research results show that the most favorable conditions for the development of leadership potential are formed under democratic and democratic–laissez-faire leadership styles, which contribute to the development of initiative, responsibility, and professional autonomy of teachers.

Ключевые слова: лидерский потенциал, педагогический коллектив, стиль руководства, образовательная организация, лидерство.

Keywords: leadership potential, teaching staff, leadership style, educational organization, leadership.

Сегодня в современных условиях развития образовательных организаций одним из важнейших аспектов педагогического коллектива является лидерский потенциал, который рассматривается как один из ключевых ресурсов развития образовательного учреждения, а также как признак инновационности, который обеспечивает устойчивость и создает условия для адаптации к изменяющимся условиям [10]. В отличие от традиционного понимания лидерства как функции исключительно ад-

министративного руководителя, современные подходы акцентируют внимание в основном на развитии определенного характера лидерства [11], где именно в образовательных и управленческих процессах основную роль играют непосредственно сами педагоги [9].

Сегодня вопросы относительно проблематики лидерства довольно часто поднимаются в обществе и становятся одними из самых актуальных, которые рассматриваются сегодня повсеместно в условиях педагогической и управленческой науки [12]. На самом деле, сам по себе феномен лидерства фактически сопровождает человечество уже на протяжении довольно длительного периода и уходит корнями вглубь истории. При этом, несмотря на это, фактическое научное осмысление его началось довольно недавно – только лишь в начале XX века. Произошло данное событие тогда, когда лидерство стало предметом систематических исследований в рамках социальных наук [14].

Термин «лидерство» в научной литературе не имеет единого универсального определения, что в основном связывают с его многогранностью и сложностью [15]. Говоря в общих чертах о самом термине, можно отметить, что данное понятие представляет собой непосредственный процесс влияния одного человека на другого, что зачастую делается для осуществления определенных целей [1]. Фактически, если вначале развития и зарождения понятия лидерства считалось, что лидером можно быть только при наличии врожденных качеств, то есть все лидерские качества формируются непосредственно при рождении, то далее, по мере трансформации различных теорий относительно развития лидерства, происходил пересмотрение его формата и в целом позиции о том, что лидерские навыки являются приобретенными, соответственно возникало мнение, что этому даже можно научиться. Также важно отметить, что для того, чтобы иметь четкое представление о том, чем фактически выступает лидерство, необходимо исследовать его трактовки различными исследователями.

Обобщенную классическую позицию трактовки термина лидерства предлагает Дафт Р., согласно которой он рассматривает лидерство как непосредственный процесс влияния на людей, с целью достижения общих целей [6]. Дэвис К. выдвигает позицию о том, что лидерство, выступает прежде всего в качестве процесса, направленного на побуждение людей осуществлять работу с определенным энтузиазмом, и что может быть направлено на достижение конкретных целей [7]. Друкер П. считает, что лидером является тот, в первую очередь, за кем могут следовать люди [8]. Барнард Ч. рассматривал лидерство как поведенческое качество, которое направляет деятельность людей в организованную деятельность [3]. Кунц Г. и О`Доннелл С. считают лидерство процессом влияния, при котором люди добровольно стремятся к достижению определенных целей [13]. В целом, сегодня современные исследователи в рамках обобщенного подхода рассматривают лидерство как комплексное социальное, разностороннее, многомерное явление [17].

Каждый из стилей руководства на основе определенных поведенческих характеристик проявляется зачастую в определенных видах, которые согласно исследованиям немецкого психолога Левина К. классифицируются как: авторитарный, демократический, либеральный (таблица 1).

Таблица 1

Виды стилей руководства

Вид стиля руководства/ критерий	Авторитарный	Демократический	Либеральный
Быстрота принятия решения	Быстро	Средне	Напрямую зависит от коллектива
Фигура, принимающая решение	Руководитель	Руководитель с учетом мнения коллектива	Коллектив
Свобода сотрудников (уровень)	Отсутствует полностью или низкий уровень	Средний уровень	Высокий уровень
Затрачиваемое руководителем время	Много	Средне	Немного
Стиль общения	Отсутствие компромиссов в общении, тотальный контроль, деловое общение в формальном виде	Внимательность, проявление терпения, дружелюбия	Мягкое и открытое общение, легко идти на уступки
Коммуникации	Только сверху вниз	Двусторонние	Сетевые (горизонтальные)
Развитие кадров/	Игнорируется (нужны исполнители)/	Поощряется в рамках плана	Является приоритетной целью
Влияние на лидерство	Подавление инициативы	Поддержка формального лидерства	Создание «лидеров среди лидеров»

Лидерский потенциал в педагогическом коллективе представляет собой не просто механическую сумму индивидуальных качеств, а выступает в качестве комплексной работы, проявляющейся в синергетическом эффекте взаимодействия педагогов [16], которые способны к взаимному влиянию и

проявлению инициативы, а также реализации совместно принимаемых решений. В целом, исследование лидерского потенциала позволяет выделить несколько основных аспектов [4], которые формируют все его проявления. Лидерский потенциал включает в себя факторы роста и ключевые качества (рисунок 1), где в качестве факторов роста рассматривается зачастую уровень обучаемости, а также личностные черты каждого отдельного педагога. В качестве ключевых качеств можно выделить: нестандартное мышление, способность учиться, уровень любопытства, умение понимать других, а также уровень эмоциональной уравновешенности [2]. Все данные факторы и качества являются очень важными, но при этом всем лидер, прежде всего, должен быть эмоционально уравновешенным, то есть уметь находить общий язык с людьми, адекватно реагировать на возникающие конфликты и ситуации [5].

Рисунок 1 – Структура лидерского потенциала

Влияние стиля руководства на развитие лидерского потенциала педагогического коллектива зачастую носит нелинейный, многоуровневый и многокомпонентный системный характер, где акцент в основном делается на роли руководителя и психологическом климате. В западных образовательных моделях же традиция фокусируется на распределении лидерства и вовлечении всего коллектива, но при этом оба подхода сводятся к тому, что благоприятные условия для развития и раскрытия лидерского потенциала создаются при демократическом-трансформационном и ситуационно-адаптивном стиле руководства, которые позволяют обеспечивать педагогов всеми необходимыми условиями, то есть формируют культуру сотрудничества, позволяют обеспечивать формирование школы из организации, которая управляется одним человеком, в организацию, где проявляется инициатива, формируется возможность брать на себя ответственность, а также где саморазвиваться может практически любой педагог, что является немаловажным для развития и обеспечения устойчивости образовательной системы в целом.

В рамках проведения практической работы реализован предварительный анализ педагогических коллективов различных школ (по методике А.Л. Журавлева), которые разделены на две основные группы: гимназии-лицеи и общеобразовательные школы. В отдельную категорию выделена JOO High School поскольку ей характерен смешанный вид стиля руководства (таблица 2).

Таблица 2

Сравнительная характеристика стилей руководства в образовательных организациям

Тип / Название организации	Гимназии и Спец. школы (Гимназия №12, Спецкомплекс №2)	JOO High School (Алатау, Ауэзов)	Общеобразовательные школы (ОШ №19, ОШ №10, Новошумная ОШ)
Преобладающий вектор	Демократический	Либерально-демократический	Авторитарно-демократический
Характерная особенность	Высокий уровень доверия к знаниям сотрудников; возможность делегирования сложных задач.	Максимальная автономность педагогов; основная нацеленность идет на самоорганизацию и инициативу.	Сочетание доброжелательности с высокими требованиями к дисциплине и порядку, но при этом фрагментарное поддержание инициативы педагогов.
Профессиональная компетентность	Высокая	Низкая	Низкая
Организаторские качества	Высокие	Низкие	Средние
Воспитание	Высокое	Высокое	Среднее
Морально-психологические качества коллектива (общение)	Высокие	Высокие	Среднее

В соответствии с таблицей 2 установлено, что гимназиям и специализированным школам преимущественно характерен демократический стиль управления, за исключением JOO High School, для которой выявлен либерально-демократический. Ключевой особенностью данных стилей является проявление высокого уровня доверия к знаниям сотрудников, делегирование сложных задач. Это связано с тем, что гимназии и лицеи в основном аккумулируют педагогов с более высокой квалификацией, ученой степенью и тех, у кого имеются собственные авторские программы. Фактически при таких стилях управления педагогам передаются не просто функции, но и ответственность за результат. Анализируя данные условия с позиции лидерского потенциала, можно отметить, что данная среда является оптимальной, поскольку она провоцирует инициативу и требует самостоятельного принятия решений, что в свою очередь благоприятно сказывается на формировании лидерства в коллективе.

В общеобразовательных школах отмечено проявление авторитарно-демократического стиля, что проявляется в сочетании доброжелательности с высокими требованиями к порядку и дисциплине, но наряду с этим прослеживается также и фрагментарное поддержание инициативы педагогического коллектива.

Для выявления уровней проявления лидерских способностей использован опросник Е. Жарикова в соответствии с результатами которого установлено, что высокий уровень лидерства был сформирован чуть более чем у одной пятой части всех респондентов (22 %). Доля преподавателей со средним уровнем лидерских способностей составила более половины (54 %) и около четверти опрошенных обладали слабым уровнем (рисунок 2).

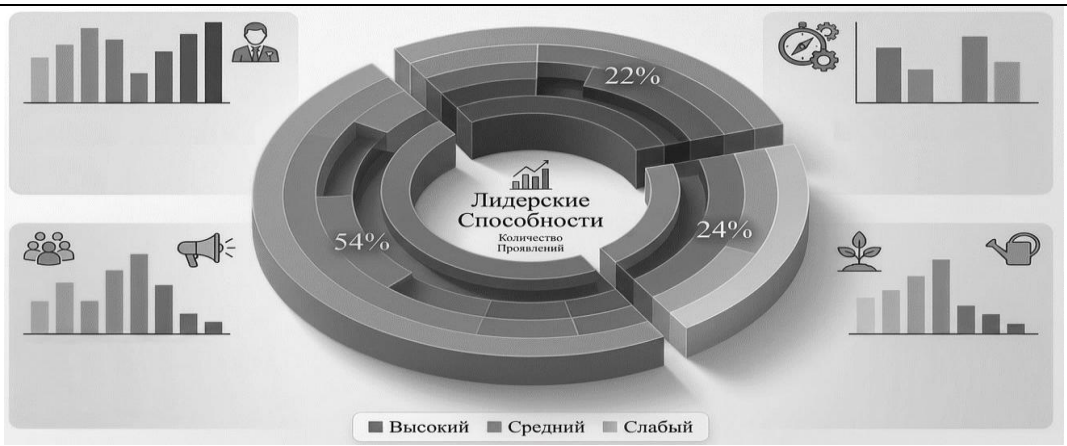

Рисунок 2 – Уровни проявления лидерских способностей

Преобладание среднего уровня можно интерпретировать как нормативный и наиболее устойчивый профиль для организации, где данная группа формирует «функциональное лидерское ядро». Однако это может сочетаться с внешним импульсом и высокой степенью ситуативности, где подобное распределение фактически снижает риски общей пассивности коллектива. Группа с высоким уровнем лидерского потенциала выполняет роль ресурса развития, где сотрудникам характерна выраженная инициативность, а также прослеживается готовность к принятию решений и склонность к преобразованиям. Даже несмотря на относительно небольшую долю, их вклад в инновационные процессы является значимым. Слабый уровень же в свою очередь формирует зону потенциального риска, но это не следует рассматривать как дефицит. Низкие показатели могут быть обусловлены различными факторами: профессиональным выгоранием, особенностями карьерного этапа или индивидуальной ориентацией на узкопрофессиональные задачи вместо управленческой активности. В данной ситуации важно понимать, что данная группа также представляет собой функциональную ценность и при необходимости разрабатывать меры поддержки и развития.

В целом выявленная структура демонстрирует сбалансированное распределение лидерского потенциала, при котором основная масса сотрудников обеспечивает стабильность системы, тогда как меньшие группы создают условия для ее развития и требуют дифференцированного управленческого подхода, что следует рассматривать как адаптивную форму лидерства, соответствующую специфике образовательной среды. Эффективное управление в данном случае предполагает не столько развитие амбиций, сколько создание безопасных и структурированных условий для проявления инициативы. Именно такая модель способствует поддержанию устойчивости образовательного процесса в условиях высокой бюрократической нагрузки и эмоциональных рисков педагогической деятельности.

References

1. Amornbunchornvej C., Berger-Wolf T. Framework for inferring leadership dynamics of complex movement from time series // Proceedings of the 2018 SIAM International Conference on Data Mining (SDM). – SIAM, 2018. – С. 549–557. – https://doi.org/10.1137/1.9781611975321.62

2. Асылбекова Л. У., Тапалова О. Б. Психофизиологические аспекты формирования компетенции «лидерство» // ҚазҰУ Хабаршысы. Психология және әлеуметтану сериясы. – 2016. – Т. 39. – № 4. – С. 57–60.

3. Barnard C. I. The functions of the executive. – Harvard University Press, 1968.

4. Горшков Н. И., Кривошеева О. Р. Leadership capacity enhancement of future physical education teachers in the professional training process // Подготовка профессиональных кадров. – 2018. – Т. 18. – № 1. – С. 75–82.

5. George J. M. Emotions and leadership: The role of emotional intelligence // Human Relations. – 2000. – Т. 53. – № 8. – С. 1027–1055.

6. Daft R. L. The leadership experience. – 6-е изд. – Cengage Learning, 2014.

7. Davis R. A. The intangibles of leadership: The 10 qualities of superior executive performance. – Jossey-Bass, 2010.

8. Drucker P. F. Management: Tasks, responsibilities, practices. – Harper & Row, 1973.

9. Zholdasbekov A., Janzakova M. Психолого-педагогические условия развития лидерских компетенций будущих педагогов // Journal of Educational Sciences. – 2021. – Т. 66. – № 1. – С. 56–64. – https://doi.org/10.26577/JES.2021.v66.i1.06

10. Куркина Н. Р., Потапова Л. Н., Мальтисова Т. В. Педагогическое лидерство и менеджмент в системе российского и зарубежного образования как фактор резильентности образовательной организации // Современные проблемы науки и образования. – 2023. – № 3.

11. Qanay G., Ball S., Mauletova Z., Shubina O., Talasspayeva G., Kurmankulova K. Emotional intelligence and teacher leadership development in schools in the UK and Kazakhstan // Pedagogical Dialogue. – 2020. – № 3. – С. 110.

12. Керимбекова А., Есенова К., Башчикулов А. Актуализация развития лидерства преподавателей колледжа // Journal of Educational Sciences. – 2025. – Т. 85. – № 4. – С. 76–88. – https://doi.org/10.26577/JES2025856

13. Koontz H., O'Donnell C. Principles of management: An analysis of managerial functions. – McGraw-Hill, 1955.

14. Liden R. C., Wang X., Wang Y. The evolution of leadership: Past insights, present trends, and future directions // Journal of Business Research. – 2025. – Т. 186. – С. 115036. – https://doi.org/10.1016/j.jbusres.2024.115036

15. McCauley P., Lee E. A call to leadership // Success strategies from women in STEM / под ред. P. A. Pritchard, C. S. Grant. – 2-е изд. – Academic Press, 2015. – С. 335–364. – https://doi.org/10.1016/B978-0-12-397181-4.00010-4

16. Рашидова Н. Р. Значение командно-лидерской компетентности педагогических кадров в профессиональных образовательных заведениях // Образование и инновационные исследования. – 2022. – № 9.

17. Wilson D. C. Defining leadership // Philosophy of Management. – 2022. – Т. 22. – № 4. – https://doi.org/10.1007/s40926-022-00210-7

PHILOLOGICAL SCIENCES

THE SUBJECT AND MAIN RESEARCH DIRECTIONS OF THE STYLISTICS

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Absract

Stylistics is characterized as the study of styles, the linguistic science that describes the functional side of the language system in the modern situation and in the diachronic aspect, as well as explains the regularities of language use in the process of speech communication. In Russian linguistics, starting from the 18th century, various problems of stylistics developed by scientists such as M.V.Lomonosov, V.V.Vinogradov, G.O.Vinokur, and M.N.Kojina etc. Several research directions (resource stylistics, functional stylistics, fictional speech stylistics, text stylistics) have been formed within the framework of the science of stylistics in 20th century Russian linguistics.

A.Demirchizadeh, A.Gurbanov, T.Efendiyeva, K.Aliyev and others have carried out extensive studies on stylistics in Azerbaijani linguistics, styles, their formation, division and distinguishing features have been interpreted in different ways. Researches in the field of stylistics in modern linguistics are mainly conducted in two directions: stylistics of language units, functional stylistics.

Keywords: stylistics, the subject of stylistics, research directions of stylistics, stylistics of language units, functional stylistics.

Stylistics and style. Although the term "stylistics" has been used in the science of philology since the 17th century, the root of this word goes back to old times. Thus, even in old times, the Greeks and Romans, who considered stylistics as rhetoric and the science of eloquence, defined its types (high style, middle style, low style). Later (at the beginning of the 20th century), the theories of language and style that emerged in the linguistics of the ancient world had a great influence on the development of scientific-theoretical ideas about style in Russian and Azerbaijani linguistics.

The thesis of the French naturalist and writer George Louis Buffon "Style is man himself" about the science of stylistics, whose main category is style, is widely spread. According to him, "*a person's character can be assessed by his style, the style reflects the author's personality and is more interesting than the subject*". In general, style is included in the terminology not only of linguistics, but also of literary studies and art studies, and it shows differences in each field of science. Linguists talk about language and speech styles, literary critics talk about the style of a work of fiction, and art critics understand style as a direction in art. Some criteria are taken as a basis for defining the style. At this time, different meanings for "style", that is, terminological and non-terminological meanings, serve to determine the nominative character of the word, reveal its features, and this fact makes its interpretation more interesting at the same time.

Stylistics in general linguistics. In modern linguistics, as in other areas of language, the study of stylistics is characterized by taking into account the characteristics of its subject. According to Y.M. Skrebnev, many areas of stylistics, like some fields of linguistics, remain undefined and are interpreted differently by representatives of different schools of linguistics [18, p.5)]. "*The complexity of determining the boundaries and structure of the subject of the style is related to the large number of synonymous terms that name both the science itself ("stylistics", "linguistic stylistics", "linguostylistics", "general stylistics") and its separate directions ("structural stylistics", "stylistics of language structure", "stylistics of resources" etc.)*" [12, p.5].

Stylistics, which arose in the framework of ancient rhetoric against the background of the study of the expressive possibilities of the word, was formed as a special field of knowledge about the possibilities and regularities of the linguistic units in different communication conditions only in the 20th century.

Modern stylistics describes and interprets various aspects of language activity and language units in the process of communication. M.N.Kojinaya believes that "*the development of stylistics as a science is connected with the gradual formation of the communicative-functional paradigm of the science of linguistics*" [13, p.409]. When characterizing stylistics, scholars mention its several components.

Referring to the most reliable sources (linguistic, encyclopedic dictionaries, works of leading specialists in this field) allows us to determine among these components "language means of expression and possibilities" [14], "the usage of language in the process of speech communication in various fields of activity [15], [9], "individual performance style of speech acts" [20] and "regularities of text organization" [21].

At the same time, stylistics is characterized as a study of styles, a linguistic science that describes the functional side of the language system in the modern situation and in the diachronic aspect, as well as explains the regularities of language use in the process of speech communication.

Three stylistic theories (high – medium – low) known since ancient times were used by Russian linguists as the basis for the stylistic description of the lexical means of the language. N.M. Karamzin addressed

the issues of fictional speech style [16]. Stylistic problems related to the development of the theory of literature and poetics in the 19th century were reflected in the works of A.A. Potebnya [19] and a number of other scientists.

The term "stylistics" itself has been consolidated in linguistics as a special field in the 20th century. German scientist K.Fossler was one of the first to declare the scientific status of stylistics. Stylistics is considered the "highest subject" in which "phonetic, morphological, orthographic and syntactic phenomena are interpreted", there individual styles of social importance (that is, "which has the greatest influence on language development") are studied. The French linguist Ch.Bally in his work "French Stylistics" (1909) examines this field as a system of knowledge about "affective categories", the legal expression of emotionality in language. He shows that there are three types of stylistics: 1) General stylistics - a science that studies general stylistic problems of speech activity related to all languages (or most languages). 2) Special stylistics - a science that studies the stylistic features of a specific national language. 3) Individual stylistics - a science that studies the expressive features that characterize the speech of individuals (8).

Stylistic problems have been developed by G. O. Vinokur [10], V.V.Vinogradov [11], D.N.Shmelyov [22] and other scientists, too.

V.V.Vinogradov, taking into account the development and presentation of relevant problems in the scientific literature in the first half of the 20th century, defines three "circles" of stylistics (stylistics of speech, stylistics of language, stylistics of fiction). These issues are the basis of the division of stylistics traditionally called *"language stylistics", "speech stylistics" and "stylistics of fiction"* [11, p.5].

In the 20th century, some specific research directions appeared within the framework of the science of stylistics in linguistics. It mainly includes *stylistics of resources* (structural stylistics, language stylistics, traditional stylistics), *functional stylistics* (instruction on functional styles, speech stylistics), *fictional speech stylistics* (fiction's language stylistics), *textual stylistics, practical stylistics*. For each of these directions, only a certain aspect of development of language units is relevant, and its description and explanation is considered the most important task facing the direction.

Stylistics of resources is based on descriptive linguistics, there the structural-semantic features of language units of different levels are reviewed, the stylistic possibilities of the units mentioned in terms of style, as well as phonetic, lexical, and grammatical means are studied. It is within the stylistics of resources that terms such as "stylistic shade", "stylistic means", "stylistic method" have emerged. One of the research subjects of stylistics of resources is descriptive and expressive means of language.

Functional stylistics studies the regularities of language activity in various socially important areas of communication. Those regularities reflect the characters of selection and organization of language units in texts related to one or another functional style in the process of communication. "Functional style", "extralinguistic factors forming functional style", "constructive principle of functional style" are the main concepts of functional style. Functional style creates a classification of functional style principles, studies the interaction of styles, their development tendencies. This direction emerged as a branch of stylistics in the 50s of the 20th century.

Stylistics of fictional speech studies the writer's personal stylistic issues, problems such as the characterization of language units in the fictional text, which determines its relationship with literary studies, functional stylistics, textual stylistics, and resource stylistics.

Text stylistics examines the structure of the text and text units in the truest sense of the word (complex syntactic whole, superphrase combinations, paragraphs, etc.) in terms of their stylistic significance and their role in creating the stylistic specificity of speech works. In the research conducted by T.V.Matveyeva [17] and other scientists, it is specially emphasized that constructive methods, the organization of relations between the structural-meaning components of the whole work or the logical units forming its basis, and the methods of expression are the subject of text style. Researches in the field of text stylistics are based on text linguistics and functional stylistic's.

Practical stylistics studies the norms of this or that functional style, the appropriateness and expediency of using language tools depending on the requirements of the style.

Thus, the concept of style, the nature and scope of the research subject, based on the theoretical and practical issues solved within this or that direction interact with different directions of stylistics.

For the purpose of summarizing the characteristics of different directions of the research subject in the stylistics, units with stylistic nuances as stylistic system components, language tools which have potential stylistic possibilities, as well as methods of organizing language units in the text are investigated. It is clear that in the process of communication, all components of the stylistic system have certain usage characteristics (they are used with varying degrees of regularity, performing certain functions in any communication situation), as well as they are characterized by a specific, stylistic relationship between them (they are either combined or opposite due to their stylistic capabilities). Their functional specificity is determined by the special nature of stylistic units, the existence of certain relations between them, the characteristics of many extralinguistic factors (communicative tasks, relations between communicants, etc.).

Stylistics in Azerbaijani linguistics. Stylistics is considered one of the youngest branches of Azerbaijani linguistics. As in general linguistics, studies on stylistics are quite extensive in Azerbaijani linguistics.

Styles, their formation, division and distinguishing features have been interpreted in different ways in the scientific literature written about style.

Styles in the modern Azerbaijani literary language have been theoretically studied for the first time in the 30s of the 20th century. The first work on this field was written by A.Taghizade and X.S.Khojayev [7]. In later

periods, styles and their borders, specifically styles, began to be studied separately. In general, there are quite extensive studies on stylistics, which is considered the youngest field of linguistics in Azerbaijani linguistics. In these scientific studies written on different levels and aspects related to style, styles, their formation, division and distinguishing features have been analyzed. It should be noted that some of the studies on stylistics in Azerbaijani linguistics are of a classification nature. Thus, there are different opinions among Azerbaijani linguists regarding the classification of styles. They put forward a separate classification of styles based on different criteria [4, 6].

As in the world languages, the styles in the Azerbaijani language can be divided into two parts according to the date of their formation:

1. Styles in the pre-writing period:
2. Styles of the writing period.

In the pre-writing period, styles such as poetic, literary-talk, everyday-literary talk, official-literary talk, but in the writing period, functional styles such as scientific, journalistic, clerical, archaic, oratorical, ceremonial etc. emerged.

As it can be seen, different styles existed in different stages of development of our literary language. Over time, these styles have changed quantitatively, increased, enriched, improved. There is no consensus among linguists and philologists about the types, number and scope of functional styles. In the division of functional styles, A. Demirchizade shows three types of styles based on the interaction of language and thinking: 1. Fictional thinking system - fictional style 2. Scientific thinking system - scientific style 3. Social - political thinking system - social style [4, p.31]. After A.Demirchizade's research, the attitude towards the study of stylistic problems, both from the point of view of literary studies and linguistics, changed.

In her research, T. Efendiyeva notes that from the beginning of the 20th century to the 50s of the 20th century, stylistics was limited to studying the language and individual writing style of individual fictional word masters, and after the 50s, literary studies and linguistics stylistics were separated. According to her, linguistic stylistics studies the national literary language as a whole, that is, it studies all styles of the literary language, including the fictional language, and tries to determine the nature of the interaction between the literary language and the fictional language. Literary stylistics only analyzes and studies the language of fiction as an aesthetic category, art material [5, p.27-28].

Researches in the field of stylistics in modern linguistics are mainly conducted in two directions [6, p.180]:

1. Stylistics of language units studies the phonetic, lexical, morphological and syntactic possibilities of language units, which combines sections such as phonetic stylistics, lexical stylistics, morphological stylistics and syntactic stylistics. These divisions of stylistics are closely related to modality. Even the prosodic means involved in the actual division of the sentence belong to stylistic phonetics. Anyone who knows the modern Azerbaijani language perfectly can create a phonetic style by means of lengthening, shortening, stress, intonation of sounds, etc. The main issue in lexical style is the choice of words. Repetitions, paronyms, synonyms etc. play a key role here. The basis of morphological stylistics is stylistic synonymy of morphological units. Parts of speech have different stylistic possibilities according to their meaning and morphological characteristics. In syntactic stylistics, word order, changing of a sentence according to purpose and intonation, stylistic points created by prosodic means, syntactic repetitions, sentence simplification, etc. play a key role. In Azerbaijani linguistics, this direction was represented by the works of T.Efendiyeva [5], A.Bagirov [2] and other scientists.

2. Functional stylistics studies and describes the system of styles, prepares the general principles of classification and definition of the main functional types of literary language, investigates the interaction of styles and their development processes. There are opinions of A.Demirchizade [4], M.Jahangirov [3], A.Akhundov [1] and others regarding this field.

Thus, we can include the following in the scope of functional stylistics by making such a generalization on the basis of reasoning, ideas and hypotheses put forward both in world linguistics and in Azerbaijani linguistics about the concept of stylistics and the subject of stylistics:

1. Analyzing and investigating the composition of language units in each functional style of the literary language, in texts belonging to this style;
2. Studying the compositional features of the texts that characteristic for each of the styles;
3. Determination of extralinguistic stylistic factors, i.e. extralinguistic situations and conditions on which the internal organization of language units depends, and methods of using them within each style;
4. Study of the division of literary language into functional styles. At this time, searching for general principles and approaches to the classification of styles in functional stylistics.

In this sense, in our opinion, it is possible to group the typical functional styles for the modern era as follows: fictional style, scientific style, journalistic style, official-business style, everyday life style.

A comprehensive study of the features of the speech structure of the styles and the composition of the most characteristic texts for each style is considered one of the main tasks of the functional stylistics of the literary language.

Conclusion. As it can be seen, the stylistic branch of linguistics is such a vast field that, no matter how much it has been studied, it still needs research. Despite the fact that there are enough studies on stylistics, whether in general linguistics or special, that is, in Azerbaijani linguistics, there are various opinions, considerations, classifications, scientific-theoretical aspects of specific areas of stylistics, as well as the formation, classification of functional styles, and their directions that manifest themselves in modern times, especially and practical issues remain undefined. In order to interpret the issues related to style, to determine the undefined features of the system of styles, more factual material should be analyzed, research should be conducted based on modern research methodology and in the light of new approaches.

References

1. Akhundov A.A. General Linguistics. Baku: East-West, - 2006, - 280 p.

2. Baghirov A. Stylistics of the Azerbaijani language (Morphology). Baku: Azerbaijan State University, 1985, 79 p.

3. Jahangirov M. Leading styles of Azerbaijani literary language in the stage of national formation. Part II. Baku: Science, 1989, 277 p.

4. Demirchizade A. Stylistics of Azerbaijani literary language. Baku: Azertadrisnashr, 1962, 272 p.

5. Efendiyeva T. Lexical style of the Azerbaijani language. Baku: "Elm" publishing house, 1980, 252 p.

6. Gurbanov A. General linguistics. Volume III (in 3 volumes). Baku, 2019, 512 p.

7. Taghizade A., Khojayev X.S. Concise Stylistics. Baku: Azernashr, 1934, 60 p.

8. Bally Ch. French stylistics / Transl. from fr. Dolinina K.A. – M., 1961. – 394 p.

9. Belchikov Y.A. Lexical stylistics: problems of studying and teaching. - 2nd ed., rev. and additional – M.: KomKniga, 2005. - 176 p.

10. Vinokur, G.O. On the tasks of the history of language/G.O. Vinokur/Selected works. – M.: Uchpedgiz, 1959. –221 p.

11. Виноградов В. В. Стилистика. Теория поэтической речи. Поэтика. М. 1963.

12. Desyaeva N.D., Arefieva S.A. Stylistics of the modern Russian language. – M., Publishing Center "Academy", 2008, - 272 p.13. Kozhina M.N. Stylistics // Stylistic encyclopedic dictionary of the Russian language / ed. M.N. Kozhina. – M., 2003. – 694 p.

14. Kozhina M.N. Stylistics of the Russian language. – M., 1993.

15. Kozhina M.N. On the foundations of functional stylistics. Perm, 1968.

16. Karamzin N.M. Pantheon of Russian Authors, LitRes, 2022, 141 p.

17. Matveeva T.V., 1990, Functional styles in the aspect of text categories, Sverdlovsk. 172 p.

18. Skrebnev Y.M. Essay on the theory of stylistics - Gorky, 1976. 174 p.

19. Potebnya A.A. Theoretical poetics / Comp., intro. Art., comment. A.B. Muratova. - M.: Higher. school, 1990. - 344 p.

20. Stepanov Y.S. Language and Method. On modern philosophy of language. - M.: "Languages of Russian Culture", 1998. - 784 p.

21. Solganik G.Y. Stylistics of the text: textbook. M., 2022, 254 p.

22. Shmelev D.N. Russian language in its functional varieties. – M.: Publishing house "Nauka", 1977. – 168 p.

POLITICAL SCIENCES

SOFT POWER AND CULTURAL DIPLOMACY IN THE SOUTH CAUCASUS

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Abstract

This paper deals with the issue of soft power and cultural diplomacy in the South Caucasus, paying attention to Armenia, Azerbaijan, and Georgia as the countries participating in the process of building regional peace. In the modern world, soft power has become one of the most efficient means of achieving international influence not by using military or economic strength but culture, values, education, and public diplomacy. The paper discusses the sources and instruments of soft power used by these three South Caucasian countries and assesses their efficiency.

Research methods used include a comparative qualitative analysis as well as an analysis of contemporary academic sources, policy papers, and official documents. The results show that Armenia, Azerbaijan, and Georgia have pursued various soft power strategies depending on their political agendas and foreign policy goals. Special focus is made on the regional environment of the post-2020 period which was formed after the Second Karabakh War and led to the changed geopolitical landscape of the South Caucasus. It is shown that cultural diplomacy, international relations, reconstruction, and connectivity have helped Azerbaijan strengthen its regional position whereas Georgia has continued employing European integration and tourism diplomacy as attraction factors. The conclusion of the article states that cultural diplomacy and soft power could be helpful for building mutual trust and cooperation as well as for building sustainable peace in the South Caucasus region.

Keywords: Soft Power; Cultural Diplomacy; South Caucasus; Peacebuilding; Azerbaijan.

1. Introduction

In the modern international system, countries not only use military and economic power but also try to appeal to foreign people through their culture, values, and diplomacy. It is often called soft power and became an important element of diplomatic activity and international relations nowadays. The increasing role of soft power is the result of a general change in global politics where the process of influencing others is done by using attraction rather than coercion. In this situation, cultural diplomacy became one of the most effective tools of soft power that allows countries to improve their national image and establish friendly ties with other nations.

As one of the regions that has proved to be quite significant when it comes to studying the concepts of soft power and cultural diplomacy, the South Caucasus consisting of Armenia, Azerbaijan, and Georgia deserves special attention. The geographical position of the region at the crossroads of Europe and Asia combined with historical peculiarities of its cultural environment, strategic importance, and political complexity make the South Caucasus a valuable case study for this research. With the collapse of the Soviet Union, the three countries started pursuing different foreign policy approaches seeking to reinforce their international standing and promote their national interests. Cultural diplomacy is one of those approaches.

However, despite being located in the same physical space, each of the three nations has taken a distinct path in the process of building soft power. Specifically, Armenia has made extensive use of its global diaspora and cultural legacy in order to raise its international profile and prestige. The Republic of Azerbaijan has concentrated its efforts on multiculturalism, hosting of international cultural events, and global public diplomacy to create a positive image of the nation and build international relationships. Georgia, on the other hand, has centered its soft power strategy on Europe integration, tourism, and education.

This issue became very relevant over the past years in the context of the changing political situation in the South Caucasus and, especially, in relation to changes in the political relations between Armenia and Azerbaijan and emerging discussions on peacebuilding. Whereas political negotiations and security structures are crucial for settling conflicts, it becomes increasingly clear that any sustainable peacebuilding needs to be accompanied by wider societal efforts aimed at achieving better mutual understanding and building trust among communities. In this context, the use of soft power and cultural diplomacy may play an important role.

The purpose of this article is to research and compare soft power and cultural diplomacy approaches of Armenia, Azerbaijan, and Georgia and to evaluate the possibility of their impact on the peacebuilding processes in the South Caucasus region. The article aims to reveal the main resources of soft power of each country and the tools used in the framework of cultural diplomacy.

As far as methodology is concerned, the article is based on qualitative comparative research. The sources used in the analysis include academic literature, policy papers, governmental documents, and publications of international organizations. By means of comparative analysis, the article explores the similar features and peculiarities of the soft power strategies of Armenia,

Azerbaijan, and Georgia and assesses their implications for regional peace-building and cooperation.

The article is organized as follows. First of all, the theoretical background of soft power and cultural diplomacy is provided. Then, the practices of Armenia, Azerbaijan, and Georgia in terms of applying the resources of soft power and tools of cultural diplomacy are discussed. In the third part of the paper, the approaches of these three countries are compared with respect to the role of soft power and cultural diplomacy in regional peace-building.

2. Literature review

Soft power and cultural diplomacy have been subjects of extensive scholarly research in the last thirty years. The development of globalization processes has led to a new approach in the study of international relations with a focus on the influence and foreign policy outcomes achieved via non-coercive instruments. Therefore, soft power has become one of the leading topics for discussion in the field of international relations.

The concept of soft power was developed by Joseph Nye in his works from 1990 and 2004, when he stated that countries are able to reach desired goals not only through the use of military and economic instruments, but also through the mechanisms of attraction and persuasion. Nye's theory suggests that culture, political values, and foreign policy are the main resources of soft power. This theory contradicts the conventional realist views in the sense that it highlights the growing importance of preferences shaping rather than the application of coercive measures in international affairs. Further researches in the area consider the methods of how governments implement different forms of cultural and diplomatic policies.

There are numerous scholarly works that consider cultural diplomacy as one of the main instruments used to exert soft power. For example, according to scholars like Mark (2009), Ang et al. (2015), and Goff (2020), cultural diplomacy is an instrument that allows the establishment of mutual understanding between nations, as well as advancing national interests in foreign affairs. Such activities as cultural exchanges, education, art cooperation, conservation, and international festivals have been recognized as efficient means of establishing diplomatic relations and increasing national prestige. Most authors recognize that cultural diplomacy helps to build long-term relationships, and can be efficient even in cases when political climate is difficult.

There are also recent studies, which draw attention to the link between soft power and public diplomacy. Thus, Melissen (2005) claims that modern diplomacy involves engagement with foreign audience and not only intergovernmental diplomacy. At the same time, Cull (2019) mentions that innovations in digital communication technologies have broadened the area of activity of public diplomacy, which gives nations the opportunity to reach global audiences with their cultural narrative and values.

Another strand of literature is concerned with the potential contributions of soft power tools in the process of conflict resolution and peace building. Authors like Nye (2011), Richmond (2014), and Anholt (2020) state that soft power tools can be helpful for building trust, reconciling conflicting sides and enhancing social cohesion in post-conflict areas. Such measures as educational exchanges, intercultural dialogue, people-to-people contacts, and other similar practices usually are considered as tools which help to decrease hostility between conflicting parties. Despite the fact that soft power cannot solve complicated political issues by itself, it can create positive preconditions for dialogue and cooperation.

As for the situation in the South Caucasus region, there is an increasing amount of academic works dealing with the issue of soft power. Existing literature states that Armenia, Azerbaijan, and Georgia use different approaches to increase their influence in the international arena. Literature devoted to the situation in Armenia pays a lot of attention to the role of Armenian diaspora which can be regarded as a unique type of soft power.

Yet another literature stream concerns the role of soft power in conflict resolution and peacebuilding. According to scholars like Nye (2011), Richmond (2014), and Anholt (2020), the use of soft power tools can facilitate trust-building, reconciliation and social cohesion in conflict-affected areas. Education exchange programs, dialogue, and interactions between individuals from different sides are often viewed as means of reducing antagonism and fostering mutual understanding. Soft power alone is not able to solve politically driven conflicts; however, it can pave the way for dialogue and cooperation.

In the context of the South Caucasus region, academic literature on soft power has been significantly developing over recent years. Current research shows that the countries of this region follow different soft power strategies. Studies on Armenia stress the importance of the Armenian diaspora as a specific type of soft power tool. It is claimed that the diaspora had an important impact on increasing international visibility of Armenia through cultural promotion and lobbying.

On the other hand, research on Azerbaijan highlights multiculturalism, international cultural events, and public diplomacy as essential elements of soft power. There is an analysis of Azerbaijan's attempts to promote itself as an intercultural dialogue hub through international conferences, cultural heritage projects, and international sports tournaments. These kinds of activities are commonly seen as tools for improving the international image and diplomacy of the country.

With respect to Georgia, most literature on the subject revolves around the country's Europeanization, tourism, and education. It is mentioned that Georgia has utilized cultural diplomacy as one of the ways to improve relationships with Europe and increase its attractiveness as a partner in the region.

Though there is an increasing number of works dedicated to soft power in the South Caucasus region, there are still some shortcomings that need to be addressed within the current literature on the topic. First, numerous articles analyze only one country and do not give a comparative assessment of soft power in Armenia, Azerbaijan, and Georgia. Another gap in the literature is lack of studies on the potential impact of soft

power and cultural diplomacy for regional peacebuilding. Though the political and security aspects of regional relations have been studied extensively, there has been no research on the role of cultural diplomacy in building dialogue and cooperation.

Thus, the aim of this paper is to address the gap in the current literature through conducting a comparative analysis of soft power and cultural diplomacy in Armenia, Azerbaijan, and Georgia and studying the relevance of these concepts to the processes of peacebuilding in the South Caucasus region.

3. Methodology: Soft Power and Cultural Diplomacy in the South Caucasus

3.1. Armenia

The strategy of soft power and cultural diplomacy of Armenia faced serious difficulties after the Second Karabakh War in 2020, when the geopolitics of the South Caucasus changed completely. Not only was there a shift in the balance of power in favor of Azerbaijan but also the ability of Armenia to use its international communication and public diplomacy practices effectively.

For quite a long time, diasporas and history were used as tools in the practice of international diplomacy of Armenia. Although these instruments helped to keep Armenia on the international map, their role was far from sufficient in order to make Armenia have a stronger impact on the region or create a more effective cooperation between the states of South Caucasus.

Several problems related to soft power have become evident during the post-conflict period. They include political instability, economic limitations, and the waning of certain traditional diplomatic discourses that weaken the country's capacity to influence other states. Also, the changes in the regional setting necessitate the readjustment of Armenia's priorities in terms of transport projects, economic connectivity, and peace talks.

One of the problems relates to the marginalization of cultural diplomacy in building regional trust. Despite the fact that cultural exchange and international cultural initiatives play an important role in conducting diplomacy, they have been limited by years of hostilities between the sides involved. Thus, the issue arises as to how Armenia can make use of cultural diplomacy for promoting regional reconciliation.

New geopolitical trends emerging in the wake of 2020 have shown that the sustainable influence of any country in the South Caucasus region is now conditioned by cooperation and peace-building activities. Under these circumstances, the future prospects of soft power of Armenia will largely be defined by its capability to adjust to the new realities of the region and contribute to initiatives promoting dialogue and cooperation in the South Caucasian region.

3.2. Azerbaijan

Azerbaijan's strategy of soft power is based on the elements of cultural diplomacy, multiculturalism, international relations, and national heritage promotion. Recently, Azerbaijan's soft power has been further boosted due to the geopolitical changes that occurred, especially because of the results of the Second Karabakh War in 2020 and the impact they had on the South Caucasus geopolitics and on Azerbaijan's regional role.

The reunification of the territories after the Second Karabakh War resulted in a new reality in the region and also increased the international visibility of Azerbaijan. The success of Azerbaijan in the military and political sense boosted its diplomatic influence and created new ways for improving its international image.

Another significant part of the soft power strategy of Azerbaijan is related to multiculturalism and intercultural dialogue. Azerbaijan has always advocated the ideas of religious tolerance, multiculturalism, and peaceful coexistence. These values have been promoted by the country in a number of international forums, conferences, and cultural events that contributed to the image of Azerbaijan as the platform of dialogue between civilizations and cultures.

Culture diplomacy is another powerful tool of the foreign policy of Azerbaijan. Azerbaijan promotes its rich culture, including music, literature, architecture, and other traditions via international exhibitions, cultural festivals, and cooperation with international organizations. The international recognition of various aspects of Azerbaijani culture has helped to increase the cultural impact of Azerbaijan in the international arena.

Moreover, Azerbaijan has made efficient use of some major international events as the tools of public diplomacy. By organizing international sporting events, forums, and other meetings Azerbaijan has managed to increase its visibility in the international arena and promote its image as the modern and internationalized country.

The restoration of the liberated territories has turned out to be one of the essential aspects of modern soft power strategies of Azerbaijan. The construction of large-scale infrastructure projects, cultural heritage restoration, and the socio-economic development of the territories have gained much attention from the international community. All these activities help to construct the story about reconstruction, development, and stability in the region.

Another major aspect of soft power is educational diplomacy that is based on the implementation of scholarship programs, educational cooperation, and cooperation with universities abroad. Thus, Azerbaijan develops its relations in the sphere of education and creates additional channels for strengthening relations between peoples.

Generally, soft power strategy of Azerbaijan helps to understand how cultural diplomacy, international activity, and post-conflict development are able to contribute to the improvement of international prestige of the state. The increase of its regional power after the Second Karabakh War in 2020 has opened new perspectives for the projection of influence.

3.3. Georgia

Georgia's soft power approach is tightly connected with the country's ambitions in Europe, the development of its tourist industry, democratization and cultural heritage promotion. Having received its independence, Georgia has been actively trying to enhance its international image by engaging with the European Union and other countries. Therefore, cultural diplomacy

has been used as an effective tool to help achieve foreign policy goals of the country.

Georgia boasts an impressive cultural heritage, including unique architectural monuments, religious landmarks, traditional musical and dance ensembles, and culinary traditions. All these elements are very useful in terms of attracting international attention and helping to build the image of the country in the world. Georgian authorities have been increasingly using cultural diplomacy in order to foster national identity and establish ties with foreigners.

Tourism can be regarded as one of the most effective soft power tools of Georgia. Millions of tourists visit Georgia each year in order to see the country's beautiful nature, historical landmarks and culture. Not only does tourism bring financial profit to the country, it also becomes a tool for promoting the culture of Georgia and enhancing its image abroad.

In this context, cooperation in the spheres of education and academics is another instrument of soft power which is actively utilized by Georgia. International exchanges of students, various partnership projects, and participation in European educational initiatives have led to establishment of closer contacts with international organizations. All these contribute to Georgia's larger goal of integration into the structures of European politics, economics, and culture.

Nevertheless, the Georgian soft power strategy also has its weaknesses. In particular, political, economic and territorial issues affect the international environment of the country. Despite all difficulties, Georgia continues to remain one of the most active participants in cultural diplomacy in the South Caucasus through such aspects as tourism, education, and European diplomacy.

It is possible to see from the experience of Armenia, Azerbaijan, and Georgia that despite the fact that these countries use different sources of attraction and influence, all three of them pay increasing attention to the use of soft power and cultural diplomacy as foreign policy tools.

4. Soft Power and the Peacebuilding Process in the South Caucasus

The region of the South Caucasus witnessed many political and geopolitical changes since the conclusion of the Second Karabakh War in 2020. The restoration of territorial integrity by Azerbaijan changed the situation in the region and shifted the balance of power. Therefore, the issues of regional connectivity, economic cooperation, and peacebuilding started to play a bigger role in academic and policy debates. While diplomacy remains the cornerstone of conflict management, soft power and cultural diplomacy were identified as tools that could contribute to the achievement of sustainable peace and stability.

The current approach to peacebuilding implies not only political agreements and military deterrence. Achieving sustainable peace is impossible without confidence-building measures, communication between societies, and the cultivation of trust between the parties to the conflict. In this context, cultural diplomacy plays a major role because it can help states promote dialogue, education, and intercultural communication.

Since 2020, the focus of Azerbaijani foreign policy has been shifting towards reconstruction, regional development and the expansion of connectivity. Reconstruction of the liberated regions and launching of major infrastructure projects have received international media coverage and have made a contribution into rising prominence of Azerbaijan in the region. All of this creates the basis for the economic interaction and cooperation of South-Caucasian countries.

Nevertheless, cultural diplomacy may be effective only provided that regional parties are ready to interact. Conflicts of past decades have formed different historical memories and mistrust of the region's peoples. Thus, peace building not only requires political compromises, but also needs long-term investments in the sphere of education, academic cooperation and cultural and people-to-people ties.

Table 1.

Comparative Overview of Soft Power Resources in Armenia, Azerbaijan and Georgia

Soft Power Dimension	Armenia	Azerbaijan	Georgia
Main Source of Influence	Diaspora networks	Multiculturalism and international engagement	European integration and tourism
Cultural Diplomacy	Heritage promotion	International cultural forums and heritage diplomacy	Cultural and educational cooperation
Public Diplomacy	Diaspora advocacy	Global events and international partnerships	European-oriented public diplomacy
Educational Diplomacy	Limited international outreach	Scholarship and academic cooperation programs	Student mobility and international education
Contribution to Regional Cooperation	Relatively limited	Increasing through connectivity initiatives	Potential mediation and dialogue platform
Post-2020 Regional Position	Adaptation to new realities	Strengthened regional influence	Balanced regional engagement

Source: Compiled by the author based on Nye (2004), Melissen (2005), Cull (2019), Goff (2020), and recent studies on South Caucasus diplomacy (2020–2025).

Table 1 highlights that each of the three states uses various tools of soft power to pursue their respective foreign policy goals. Specifically, Armenia keeps using diasporic influence as its primary tool, while Georgia

builds on European integration and tourism diplomacy. Azerbaijan uses multiculturalism, international activity, cultural diplomacy, and post-conflict reconstruction initiatives.

Moreover, there are also some notable disparities regarding the ability of each country to engage in regional cooperation. After 2020, Azerbaijan got new possibilities for the promotion of connectivity and development diplomacy, which makes this country more involved in regional matters. In turn, Georgia is quite balanced, and this country may play the role of an intermediate between the other two, while Armenia still faces problems related to adaptation to changing geopolitics. Thus, it is possible to conclude that now Azerbaijan and Georgia have more chances to use soft power for regional peacebuilding and cooperation.

The connection between soft power and peacebuilding in the South Caucasus can be described as follows.

Figure 1 below offers an example of a model illustrating how the process of utilizing soft power might help promote the peacebuilding processes in the South Caucasus. According to the model offered, the cultural assets, education, public diplomacy, and international activities can be regarded as the pillars of soft power. These assets can be used in practice in the form of cultural diplomacy through activities including academic exchange, cultural activities, inter-cultural dialogues, and cooperation with institutions.

The model also shows that the stage of building confidence is the vital intermediate step from the cultural contact to peace. In the case of territories suffering from historical conflicts, like the South Caucasus, trust deficits usually persist even after the end of military conflicts. Therefore, only political arrangements cannot guarantee sustainable peace. Cultural diplomacy can offer an opportunity for communication between societies.

The concept is especially important in the post-2020 regional setting. With the advent of new possibilities in terms of economic connectivity, infrastructure development, and regional cooperation, it became increasingly significant to rely on non-coercive methods of influence. In this regard, the successful implementation of soft power tools in broader peacebuilding efforts can have a great impact on the stability and reconciliation in the region.

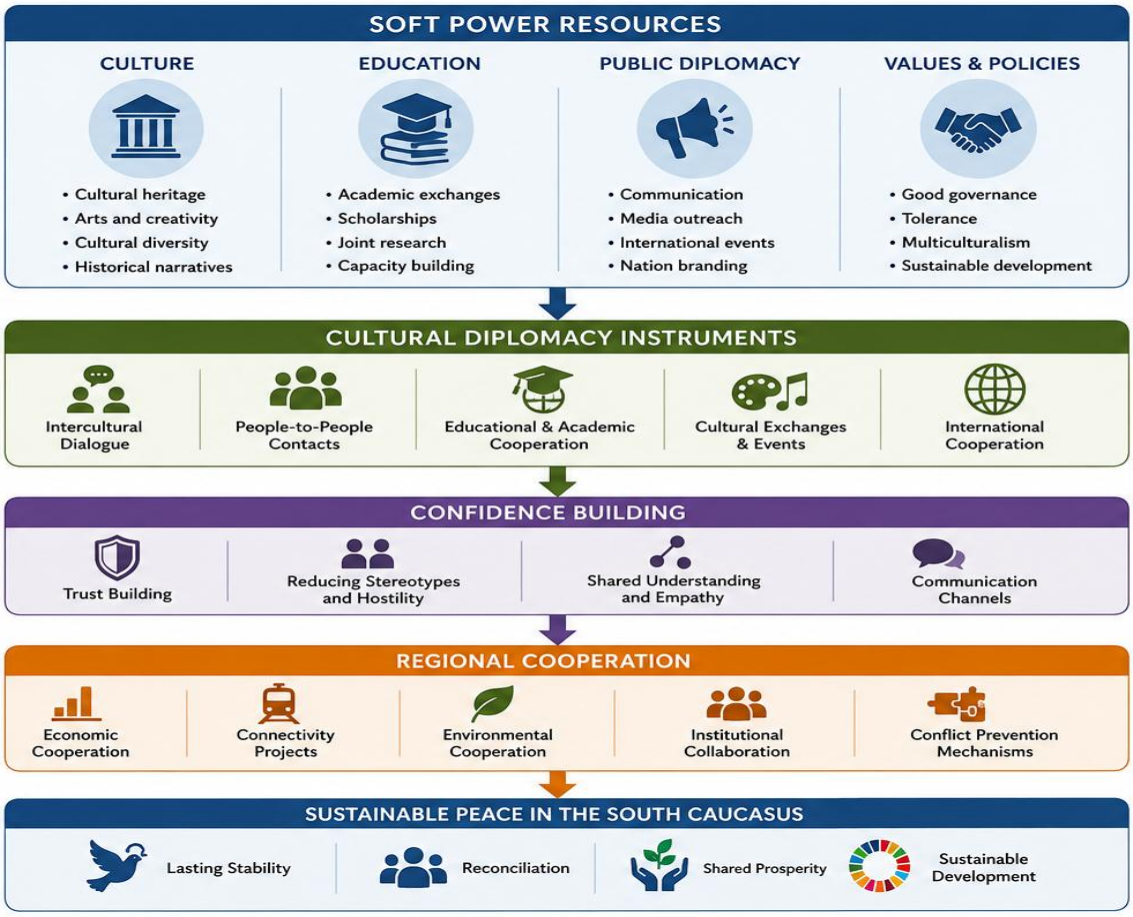

Figure 1. Soft Power and Peacebuilding Framework in the South Caucasus
Source: Author's compilation based on Nye (2004), Melissen (2005), Richmond (2014), Cull (2019), and Goff (2020).

It can be seen from the discussion above that soft power and cultural diplomacy must be seen not only as additional foreign policy instruments but also as an essential tool for building peace in the region. However, their efficacy requires continuous political engagement and readiness of regional players for constructive cooperation.

5. Conclusion

This article analyzed the phenomenon of soft power and cultural diplomacy in the South Caucasus,

particularly in terms of how Armenia, Azerbaijan, and Georgia use soft power and its influence on regional peacebuilding. It was proved that, although all three countries operate under the same geopolitical circumstances, each one uses its own approach towards soft power in view of its history, foreign policy priorities, and international position.

It became evident during the literature review that soft power has turned into an essential component of international relations, alongside such traditional instruments of influence as military and economic power. Some of the best ways to improve country's image and its influence include cultural diplomacy, educational cooperation, public diplomacy, and engagement of the people. Modern research also emphasizes the importance of soft power in peacebuilding and conflict resolution.

In comparison with each other, the South Caucasian states revealed considerable disparities in their approaches to foreign relations. In the context of the research under consideration, the Republic of Armenia has been employing diaspora networks and historical discourse as the instruments of international outreach. Yet, the efficacy of those instruments is limited by the regional political context as well as the new geopolitical reality after the Second Karabakh War. Georgia is characterized by the development of its foreign policy tools through tourism diplomacy, educational interaction, and European integration. As for the Republic of Azerbaijan, this country uses a multidimensional strategy of soft power that implies multiculturalism, cultural diplomacy, international engagement, and public diplomacy.

One of the most important conclusions that have been drawn from the course of the research is connected with the effect of the Second Karabakh War of 2020 on the dynamics of the region. The restoration of the territorial integrity of Azerbaijan has resulted in a new political reality in the South Caucasus. In the post-war period, Azerbaijan has been increasing its attention to such elements as reconstruction, regional connectivity, and economic cooperation. These aspects have become the part of its diplomatic strategy.

In addition, the study showed that cultural diplomacy may assist in peace building through the means of dialogue, building up mutual understanding, and lowering barriers between societies. While soft power alone may not solve political disagreements, it can provide good ground for building up confidence and eventual reconciliation. Educational and cultural programs, as well as cooperation in academics and public diplomacy, may assist in supplementing the diplomatic work done and promoting sustainable peace.

It was shown that the success of the region in terms of stable relations in the future will depend not only on the political decisions but also on successful establishment of cooperative relations between societies in the region. In this context, soft power and cultural diplomacy need to be included in larger peace building efforts.

Some policy recommendations could be suggested based on the results of this research. First, regional actors are advised to increase the number of cultural and educational exchange programs which promote direct contacts between the students, academic circles, and cultural agencies. Second, international organizations are advised to promote the initiatives aimed at improving intercultural dialogue and confidence-building in the region. Third, governments are recommended to see the strategic value of cultural diplomacy as an instrument of long-term investment in the region. And finally, there should be more focus on the issue of connectivity, reconstruction, and development.

To summarize, the region of South Caucasus is entering a new stage of regional development facing numerous challenges but also having many opportunities. Despite the existence of historical conflicts and political contradictions which continue to affect the nature of regional relations, the instruments of soft power and cultural diplomacy remain helpful tools for building sustainable cooperation and peace. The proper use of those instruments will allow achieving peace and prosperity in the region of South Caucasus.

References

1. Ang, I., Isar, Y. R., & Mar, P. (2015). Cultural diplomacy: Beyond the national interest? *International Journal of Cultural Policy*, 21(4), 365–381.

2. Cornell, S. E. (2020). *The International Politics of the Armenian-Azerbaijani Conflict: The Original "Frozen Conflict" and European Security*. Stockholm: Institute for Security and Development Policy.

3. Cull, N. J. (2019). *Public Diplomacy: Foundations for Global Engagement in the Digital Age*. Cambridge: Polity Press.

4. German Marshall Fund. (2024). *Transatlantic Trends and Regional Cooperation in the South Caucasus*. Washington, DC: German Marshall Fund.

5. Goff, P. M. (2020). *The Routledge Handbook of Public Diplomacy* (2nd ed.). London: Routledge.

6. Gregory, B. (2020). Public diplomacy and soft power. In N. Snow & N. J. Cull (Eds.), *Routledge Handbook of Public Diplomacy* (2nd ed., pp. 65–78). London: Routledge.

7. Melissen, J. (Ed.). (2005). *The New Public Diplomacy: Soft Power in International Relations*. New York: Palgrave Macmillan.

8. Nye, J. S. (2004). *Soft Power: The Means to Success in World Politics*. New York: PublicAffairs.

9. Nye, J. S. (2011). *The Future of Power*. New York: PublicAffairs.

10. Richmond, O. P. (2014). *Failed Statebuilding: Intervention, the State, and the Dynamics of Peace Formation*. New Haven: Yale University Press.

11. Snow, N., & Cull, N. J. (Eds.). (2020). *Routledge Handbook of Public Diplomacy* (2nd ed.). London: Routledge.

12. Zaharna, R. S. (2022). *Boundary Spanners of Humanity: Three Logics of Communications and Public Diplomacy for Global Collaboration*. Oxford: Oxford University Press.

SOCIAL SCIENCES

ARCHAEOBOTANICAL EVIDENCE AS REFLECTION OF HEALING AND RITUAL PRACTICES (INTERDISCIPLINARY APPROACH BASED ON ARCHAEOLOGICAL DATA)

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Abstract

This article examines the relationship between two important fields of the humanities and natural sciences – archaeobotany and folk medicine – which together provide new perspectives for understanding the history of plant use in healing practices. Archaeobotany has the potential to significantly expand our knowledge of the origins and evolution of traditional medicine. Through the analysis of plant and wood remains, as well as organic residues preserved on artifacts, it provides valuable information about the plants utilized by ancient societies and their role in everyday life. Folk medicine, in contrast, represents a living tradition based on centuries of empirical observations and practices, in which knowledge of the medicinal properties of plants has been transmitted from generation to generation and integrated into local cultural traditions.

The present study analyzes artifacts, seeds, and other botanical remains recovered from archaeological sites and compares them with contemporary practices of plant use in the folk medicine of various cultures. Particular attention is given to materials from the archaeological sites of Kanka in the Tashkent region, Kafir-kala in the Samarkand region, and the Fergana Valley, where archaeobotanical investigations have revealed substantial evidence of plants employed in both subsistence activities and healing practices. The analysis of these data highlights the importance of an interdisciplinary approach combining archaeology, ethnography, and biology to achieve a more comprehensive understanding of ancient healing traditions.

Thus, the present study establishes a bridge between the past and the present, emphasizing the importance of preserving traditional knowledge concerning medicinal plants for future generations and demonstrating the prospects for its application in contemporary scientific and cultural contexts.

Keywords: Central Asia; interdisciplinary studies; folk medicine, archaeobotany; traditional medicine knowledge, ritual practices, human-plant interactions, plant remains.

Introduction

Archaeobotany, which emerged at the intersection of archaeology, botany, and social anthropology, constitutes an interdisciplinary field of research that plays a crucial role in reconstructing past interactions between humans and the plant world. Archaeobotanical evidence makes it possible to trace major historical processes, including the origins of agriculture, climatic fluctuations, and cultural transformations in human societies. Plant remains represented by seeds, pollen, phytoliths, wood fragments provide an opportunity to reconstruct ancient medicinal practices that predate written sources.

Throughout human history, knowledge concerning the properties of plants and other natural resources developed through direct interaction with the environment. Observations of natural phenomena and practical experience contributed to the formation of ideas regarding the use of plant resources in the treatment of diseases. The transmission of such knowledge from one generation to another became the foundation of folk medicine, certain elements of which remain relevant today. In pre-industrial societies, plants occupied a central place within subsistence systems, serving not only as sources of food and raw materials but also performing healing function. Archaeobotanical studies indicate the widespread use of medicinal plants in antiquity. Remains of wormwood (*Artemisia spp.*), yarrow (*Achillea millefolium*), sage (*Salvia spp.*), and mint (*Mentha spp.*) have been identified in Bronze Age cultural deposits. Botanical remains have been recovered from domestic and funerary contexts, frequently associated with ceramic vessels and animal bones, suggesting their multifunctional use. These plants were probably employed not only for healing purposes but also in ritual activities, including purification and apotropaic practices. In this respect, Central Asia, characterized by considerable ecological and cultural diversity, represents a promising region for investigating the origins and development of traditional healing practices.

Archaeobotanical materials obtained from different archaeological sites have made a significant contribution to our understanding of human-plant interactions in Central Asia. At the site of Kanka in the Tashkent region of Uzbekistan, remains of cultivated plants, including grapes and cotton, have been identified, indicating a highly developed agricultural and horticultural economy. At Afrasiab settlement archaeologists have recovered remains of grapes, wheat, and millet, together with plants possessing medicinal properties, including mint, sage, and wormwood. At Kafir-kala in the Samarkand region, seeds and wood remains recovered from the pre-Islamic layers of the citadel have been interpreted as materials used not only for economic purposes but possibly also in ritual practices (Murakami et al., 2025). Furthermore, remains of millet

and leguminous crops have been discovered at Bronze Age settlements in the Surkhandarya region, broadening our understanding of subsistence strategies and plant exploitation among ancient populations.

Discussion

Medicinal plants have long been used in traditional medicine as important sources of biologically active compounds, including flavonoids, phenolic compounds, alkaloids, essential oils, glycosides, terpenoids, and phytoncides. These secondary metabolites are largely responsible for the therapeutic properties of plants and are known to exhibit antioxidant, antibacterial, and immunomodulatory effects.

One of the most remarkable examples of a plant possessing both nutritional and medicinal value is the Persian walnut (*Juglans regia*). This species has a long history of use in Central Asia, where it has occupied an important place in traditional culture and folk medicine. In the region, walnut trees are widely cultivated as fruit-bearing species and are well adapted to local climatic conditions, ensuring stable yields. Walnuts are extensively used in regional cuisine and are incorporated into a variety of dishes, including salads and confectionery products. They are also frequently added to traditional dishes such as pilaf, contributing both texture and flavor.

In folk medicine, walnuts have long been valued for their beneficial properties. Nuts and walnut oil have been used to improve digestion, strengthen the immune system, and promote skin health. Walnut wood, characterized by its durability and attractive grain, has traditionally been employed in the manufacture of furniture and artistic objects. It is therefore not surprising that in many traditional cultures the walnut tree has been associated with wealth, fertility, and longevity.

Fig. 1. Fragment of a walnut shell. Kanka settlement.

An equally important place in the culture and everyday life of peoples from various regions is occupied by the peach (*Prunus persica*), renowned for its sweet and aromatic fruits.

Fig. 2. Peach pit (Prunus persica L.) recovered from the archaeological site of Kanka.

The peach is widely distributed throughout many regions of the world, including Central Asia. Its fruits are rich in vitamins C and A, antioxidants, minerals, and potassium, contributing to immune support and the regulation of cholesterol levels and blood pressure. Beyond its nutritional and medicinal value, the peach possesses profound symbolic meanings in many cultural traditions, where it is associated with fertility, love, and prosperity. In Chinese tradition, the peach is regarded as a symbol of longevity and immortality (Shafer, 1981). Japanese mythology preserves the legend of Momotaro, or the “Peach Boy”, who, according to tradition, was discovered inside a peach and later defeated evil demons. Consequently, the peach acquired an important place in Japanese culture, becoming associated with protection against malevolent forces and the triumph of good over evil (Knappert, 1992). Thus, the peach represents not only a valuable food resource but also a powerful cultural symbol whose symbolic meanings have inspired artistic creativity and philosophical reflection for centuries.

Alongside fruit crops, aromatic plants occupied an important place in the traditional culture and ethnomedical practices of many societies. Basil (*Ocimum spp.*), for example, contains 1–1.5% essential oils, up to 6% tannins, as well as glycosides, saponins, mineral compounds, vitamins, and camphor (Pearsall, 2000). Owing to these constituents, basil is known for its tonic and anti-inflammatory properties.

Although basil is believed to have originated in South Asia, it is now widely distributed across Africa and South America. The earliest written references to the plant were recorded in China and date to the first century CE (Shefer, 1981). Basil occupied a special position in ancient Egyptian culture, where it was regarded as a sacred plant capable of facilitating the passage into the afterlife. For this reason, its remains have

been recovered from royal tombs, and the plant itself was employed in mummification rituals. In India, basil continues to be one of the most revered plants, surpassed in symbolic importance only by the lotus.

Since antiquity, basil has been used in ethnomedical practices owing to its antiseptic, bactericidal, antipyretic, and analgesic properties. Its pharmacological significance is associated with its high concentrations of essential oils, tannins, ascorbic acid, and camphor. Over time, basil became firmly integrated into the culinary traditions of Central Asia and continues to be widely utilized as both a food resource and a medicinal plant.

Important evidence concerning ritualized plant use in funerary contexts was obtained during investigations at the archaeological site of Munchaktepa in the Fergana Valley. In several burials, archaeologists documented small accumulations of leaves and branches located inside and around reed coffins, as well as directly on the remains of the deceased. Archaeobotanical analyses revealed the presence of mint leaves, pepper grains, and basil. It is possible that these aromatic plants were used to retard decomposition and reduce unpleasant odors. From an anthropological perspective, such practices may also have possessed symbolic meanings and apotropaic functions associated with protection and purification. Ethnographic evidence suggests that this tradition may have been characteristic of populations closely connected with agricultural lifeways.

In addition to aromatic and culinary plants, species possessing pronounced pharmacological properties played a significant role in the ethnomedical and ritual practices of ancient societies. One of the most remarkable examples is the opium poppy (*Papaver somniferum L.*), which is believed to have originated in the eastern Mediterranean and Asia Minor. Although this species is now widely distributed throughout temperate regions, its history of use extends back several millennia to the Neolithic period (Merlin, 1984). Since ancient times, the opium poppy has served as a source of opium obtained from the dried latex of immature seed capsules. The earliest written evidence of its use originates from Sumerian civilization. According to cuneiform tablets dating to the middle of the third millennium BCE, opium was employed both as a medicinal substance and in ritual contexts. During subsequent periods, traditions associated with poppy use became widespread. Ancient Greeks are known to have consumed an opium-based preparation known as nepenthes, or the “drink of forgetfulness”, while the earliest evidence for poppy cultivation in China dates to the eighth century CE. In various cultural traditions, the plant was used to relieve pain, reduce fatigue and anxiety, and induce sleep. The significance of the opium poppy, however, extended far beyond the medical sphere. In many societies, the plant occupied an important place in rituals associated with healing, protection, and preparation for sacred activities. It has been suggested that Sumerian priests employed the plant to induce altered states of consciousness during ritual performances. Thus, the pharmacological properties of the opium poppy were closely intertwined with its symbolic meanings, reflecting the characteristic integration of ethnomedical practices and religious-magical beliefs in ancient societies. This relationship illustrates the inseparability of practical healing traditions and symbolic systems that structured human interactions with the plant world throughout history.

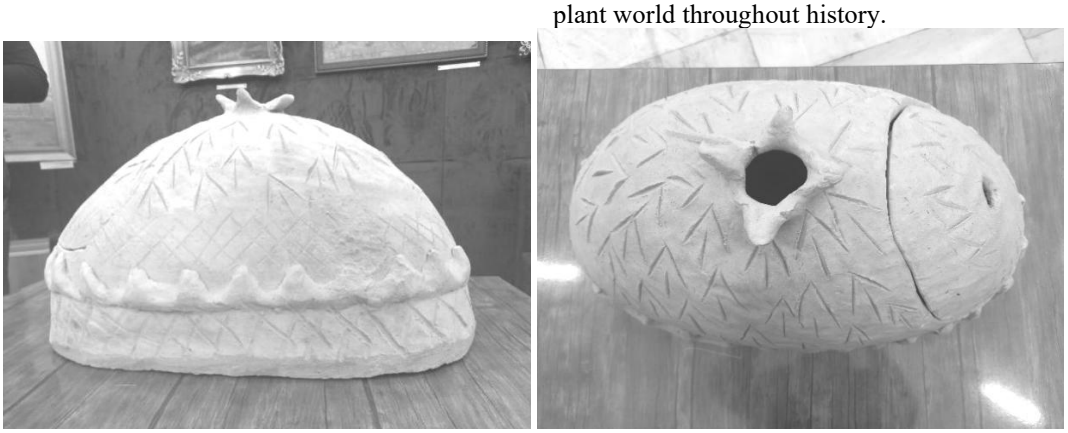

Fig. 3. Ossuary in the shape of an opium poppy (Papaver somniferum L.). Museum of Chirchik, Republic of Uzbekistan. Discovered at Yugontepa. 7th–8th centuries CE.

When discussing healing plants that were widely employed in the medical traditions of various cultures in antiquity, it is important to mention another species extensively used in Central Asia - Syrian rue (*Peganum harmala L.*), commonly known as *isyrik*. This plant occupied a prominent place in the ethnomedical practices and ritual traditions of the region and has long been recognized for both its therapeutic properties and symbolic meanings.

Fig. 4. Syrian rue (Peganum harmala L.).

This species is well adapted to arid environments and commonly occurs in deserts, steppes, and on rocky slopes. The healing properties of Syrian rue are largely determined by its chemical composition, particularly the presence of alkaloids such as harmaline and harmine. Although the plant is toxic and may cause respiratory disorders, nausea, hallucinations, and convulsions, it has been widely employed in traditional ethnomedical practices. References to *Peganum harmala* can be found in the works of the Greek physician Dioscorides (Ist century CE), in Avicenna's Canon of Medicine (980–1037 CE), and in the writings of the distinguished Muslim scholar and encyclopedist Abu Hanifa al-Dinawari (815–895 CE), author of the Book of Plants (Kitab al-Nabat), who recommended a decoction of Syrian rue roots for the treatment of severe fevers. The healing and symbolic properties of this plant were also recognized by dervishes, who incorporated it into purification rituals. Throughout Central Asia, as well as in several countries including India and Pakistan, the smoke of Syrian rue has traditionally been used to expel malevolent spirits from dwellings and to provide protection against the evil eye. In this context, the plant acquired important symbolic meanings and fulfilled apotropaic functions within local belief systems. Remarkably, these ritualized forms of plant use have persisted into the present day, illustrating the continuity of traditional ecological knowledge and the enduring relationship between healing practices and religious-magical beliefs.

Fig. 5. Fragment of a vessel decorated with representations of Syrian rue (Peganum harmala). Kafir-kala, 7th–8th centuries CE.

In addition to Syrian rue, other representatives of the native flora played an important role in the healing practices and subsistence activities of populations inhabiting the arid regions of Central Asia. Among these species, camelthorn (*Alhagi pseudalhagi* or *Alhagi persarum*) deserves particular attention. Owing to its remarkable resilience and wide range of useful properties, this plant attracted human attention from an early period. It has been regarded as a potential source of food, medicinal raw materials, and fuel in ancient societies of Central Asia and the Near East. In traditional medicine, camelthorn was used as an antiseptic, as well as a choleretic and anti-inflammatory remedy. Although direct finds of *Alhagi* seeds are relatively rare in the archaeological record of Central Asia, representatives of this genus have been identified within archaeobotanical assemblages in the form of charred remains together with other wild plant species. For example, the presence of *Alhagi* sp. has been documented in Late Bronze Age materials from Tilla-Bulak in southern Uzbekistan (Mir-Makhamad et al., 2026). These findings suggest that local communities actively incorporated native vegetation into their subsistence strategies and ethnomedical practices. Moreover, the persistence of camelthorn in the cultural traditions of the region reflects the continuity of traditional ecological knowledge and long-standing patterns of human-plant interactions.

Conclusion

The present study demonstrates that the material traces of medicinal plant use represent not merely biological resources, but repositories of cultural knowledge and symbolic meanings embedded within particular social and ecological contexts. The integration of evidence derived from botany, archaeology, eth-

nography, and pharmacology provides a holistic framework for understanding how the selection, preparation, and application of plants contributed to community health, ecosystem resilience, and processes of cultural exchange. Such an approach enables a more comprehensive reconstruction of past lifeways and the cultural contexts in which ethnomedical practices developed.

The interdisciplinary dialogue between archaeobotany and folk medicine contributes significantly to reconstructing historical perceptions of human interactions with natural resources and establishes a solid foundation for the conservation of biological diversity, the respectful treatment of traditional knowledge systems, and the further development of medical science. By revealing the deep historical roots of ethnomedical practices and ritualized plant use, such research facilitates the transformation of cultural heritage into sustainable approaches to future healthcare while preserving cultural continuity and promoting the safeguarding of traditional ecological knowledge for future generations.

References

1. Al'baum, L. I. (1960). *Balalyk-tepe. K istorii material'noi kul'tury i iskusstva Tokharistana*. Tashkent.

2. Askarov, O. (2020). The role of paleobotanical data in the study of the Central Asian region (Southern Turkmenistan). *International Journal of Academic and Applied Research (IJAAR)*, 2–3.

3. Bogomolov, G. I. (2020). Reznoe derevo Kafir-kaly. In *Sogdiana – serdtse Shelkovogo puti* (Seriya *Kul'turnoe nasledie Uzbekistana*, Vol. 35, pp. 142–156). Silk Road Media & East Star Media.

4. Charles, M., & Bogaard, A. (2010). Charred plant macro-remains from Jeitun: Implications for early cultivation and herding practices in Western Central Asia. In D. Harris (Ed.), *Origins of agriculture in Western Central Asia: An environmental-archaeological study*. University of Pennsylvania Museum of Archaeology and Anthropology, 150–165.

5. Gubanov, I. A. (1976). *Dikorastushchie poleznye rasteniya SSSR* (pp. 207–209). Mysl'.

6. Harris, D., Masson, V., Berezkin, Y., Charles, M., Gosden, C., et al. (1993). Investigating early agriculture in Central Asia: New research at Jeitun, Turkmenistan. *Antiquity, 67*, 324–338.

7. Knappert, J. (1992). *Pacific Mythology: An Encyclopedia of Myth and Legend*. London: Aquarian Press.

8. Kryukova, V. Yu. (2005). *Zoroastrizm*, 193–196.

9. Merlin, M. D. (1984). *On the Trail of the Ancient Opium Poppy*. Associated University Presses, 54-58.

10. Mir-Makhamad, B., Spengler III, R., Motuzaite Matuzeviciute, G., Zach, B., Sarkady, C., & Kaniuth, K. (2026). Seeds of time: Archaeobotanical insights into Late Bronze Age agriculture from the heart of Central Asia. *Human Ecology, 54,* Article 25. https://doi.org/10.1007/s10745-026-00680-7.

11. Murakami, T., Watanabe, Y., Begmatov, A., Berdimurodov, A., Bogomolov, G., Sandiboev, A., Teramura, H., & Uno, T. (2025). *Timber and flora from Kafir-Kala in Samarkand: Unveiling species and practical applications*. *O'zbekiston arxeologiyasi, 2*, 74–94. https://doi.org/10.71414/2181-032X-2023-2-29-74-94.

12. Pearsall D.M. (2000) *Paleoethnobotany:* A Handbook of Procedures. – 2nd ed. – San Diego: Academic Press, p.165.

13. Shefer, E. (1981). *Zolotye persiki Samarkanda: Kniga o chuzhezemnykh dikovinakh v imperii Tan*. Vostochnaya literatura, 151, 236–237.

14. Spengler, R. N. (2019). Archaeobotanical evidence for early cereal use at the site of Aigyrzhal-2 in Kyrgyzstan. *Journal of Archaeological Science: Reports, 24*, 588–595.

TECHNICAL SCIENCES

OPERATIONAL CHALLENGES OF AUTONOMOUS MARITIME NAVIGATION UNDER EXTREME AND ABNORMAL CONDITIONS

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Abstract
The development of autonomous ships marks a new era in maritime transport. Modern vessels increasingly rely on algorithms, integrated sensors, and artificial intelligence for navigation and control. Consequently, the role of humans is gradually shifting toward remote control and supervision. Technological innovations in the maritime industry are driving rapid progress, enabling the commercial operation of autonomous vessels, both remotely controlled and fully autonomous. This transformation requires strict regulation to ensure the safety of human life at sea, cargo security, and vessel integrity. "Autonomous ships represent an innovative development promising increased efficiency, safety, and sustainability" [1].

This paper examines the principles of autonomous course correction, the role of artificial intelligence and machine learning in modern navigation, as well as the main challenges related to safety and legal regulation of autonomous maritime systems.

Keywords: Autonomous ships, Cybersecurity, Risk Assessment.

Introduction

To define the levels of autonomous navigation, organizations such as the International Maritime Organization (IMO), Lloyd's Register, and Rolls-Royce have developed their own autonomy frameworks. The International Maritime Organization introduced the MASS (Maritime Autonomous Surface Ships) framework, which defines four progressive levels of autonomy. This system focuses primarily on the location of control and the presence of crew onboard. The levels range from ships with automated systems supporting the crew (MASS 1.0), through vessels remotely controlled from shore either with crew for backup control (MASS 2.0) or without crew (MASS 3.0), and culminate in the fully autonomous ship (MASS 4.0), which makes decisions entirely independently [2].

Lloyd's Register applies its autonomy level (AL) scale, which is more detailed and consists of seven main stages (from AL 0 to AL 6). This framework emphasizes the degree of decision support and the role of humans in the operational cycle. It starts with fully manual operation (AL 0), proceeds through various levels where decision support is provided (from onboard and shore-based systems – AL 1 and AL 2). At higher levels, the focus is on whether the human acts as an active supervisor (AL 3) or remains only "in the loop" (AL 4), and ends with fully autonomous operation (AL 6) requiring no human intervention.

Rolls-Royce offers the most detailed system, consisting of ten levels (from L1 to L10). This framework focuses on the degree of computer intervention and the human right of veto or control. The levels begin with full human control (L1), without computer assistance, and gradually increase the system's role—from proposing alternatives (L2, L3, L4) to automatic execution with human veto capability (L5 and L6). The highest levels (L7 to L10) describe systems that operate fully independently, informing humans less frequently, until at L10 the computer performs all tasks completely autonomously regardless of human involvement.

The classification of the International Maritime Organization is the most widely adopted and serves as the basis for international regulatory and technical discussions.

Use of Artificial Intelligence in Autonomous Ship Control

Autonomous ships perform course correction and navigation using complex systems that replace human decision-making. They employ multiple sensors, including radar, lidar, cameras (visual and thermal), GPS, sonar, and AIS. Data from these sensors are combined through sensor fusion algorithms, overcoming individual sensor limitations and creating a more reliable and comprehensive picture of the maritime environment. Artificial intelligence-based software processes this data in real time to enable autonomous navigation along complex routes and dynamic collision avoidance [3].

Autonomous vessels can apply advanced route-planning algorithms that minimize fuel consumption and consequently reduce greenhouse gas emissions. At the highest level of autonomy (MASS 4.0), the ship's operating system independently makes decisions and determines actions. Artificial intelligence (AI) and machine learning (ML) are fundamental to enabling autonomous ships to function independently. They are also critical for safe and efficient operation. AI-based algorithms underpin situational awareness and decision-making, allowing ships to determine their actions autonomously. AI systems process sensor information to assess the current maritime situation and make navigation decisions. Processed data are transformed into visually interpretable and actionable information for both onboard systems and remote operators. Machine learning and sensors are used to monitor component conditions in real time and predict potential failures. This is particularly important for unmanned ships, where emergency maintenance capabilities are limited. Machine learning models are computer algorithms capable of learning and improving performance in a specific task based on accumulated experience without being

explicitly programmed for every step. The three main types of machine learning are:

- Supervised learning – the model is trained using input data with corresponding output labels, learning relationships between data and outcomes.
- Unsupervised learning – the model works with unlabeled data and autonomously identifies patterns, groups, or structures.
- Reinforcement learning – involves interaction between the model and the environment; the model performs actions, receives positive or negative feedback, and gradually learns which strategy yields the best results.

Modern ML models most often rely on artificial neural networks (structures inspired by the functioning of the human brain). These models are often referred to as "black boxes" because it is difficult to explain precisely how they reach specific outcomes. Therefore, their reliability cannot be verified using traditional software testing methods, and instead requires statistical approaches for verification and validation based on large datasets.

In the context of autonomous navigation, machine learning is applied in several areas:

- Signal classification – recognition of the type of received data;
- Object detection – identification of objects and determination of their positions;
- Semantic segmentation – classification of each element of an image or signal according to the object category;
- Regression models – used for numerical predictions, such as forecasting ship trajectories;
- Reinforcement learning-based control – applied to develop behavioral strategies in situations where predefined rules are difficult to establish.

Despite its significant potential, direct control of autonomous ships solely through machine learning models is not always the most appropriate solution. In many cases, more reliable and predictable results are achieved using conventional algorithms based on optimization and predefined rules. Therefore, ML models are primarily used as a supporting component that increases adaptability and efficiency of the navigation system. One of their most valuable applications is long-term maritime traffic prediction, where the model forecasts future trajectories of other vessels.

Operation of Autonomous Systems in Adverse and Emergency Situations

Navigation is one of the most critical safety functions in maritime operations and will be most strongly affected by the introduction of autonomous ships. As autonomous navigation systems assume the functions of the human crew, navigational risk shifts from human error to technological risks. Therefore, autonomous navigation systems must form the foundation of future regulatory frameworks for autonomous shipping [4]. In conventional ships, regulation covers watch organization, navigation equipment, and crew qualifications. In autonomous systems, however, navigation technologies become the primary subject of control due to limited human participation. Standards must differ depending on ship type and operational environment:

- For unmanned ships, high reliability is required because no human intervention is available.
- For crewed ships, more flexible requirements may apply provided the crew can respond in time.

Autonomous navigation systems should be regulated through a combination of technological and manufacturing standards verified through simulations and real-time testing. Crews of autonomous ships act as a backup navigation system, and interaction between humans and autonomous technologies must be carefully studied to avoid overloading operators in shore control centers.

Responsibility in case of incidents should be determined according to the capacity for action:

- In autonomous operations – responsibility lies with the owner or system developer;
- In remote control operations – with shore operators if the error could have been avoided.

Serious challenges to situational awareness systems of autonomous ships arise under the following conditions:

- Difficult environmental conditions – adverse weather such as dense fog, heavy rain, or snow significantly reduces visibility and impairs sensor performance, especially cameras and lidars operating in visible and infrared spectra. In such cases, autonomous navigation systems must rely primarily on radar and acoustic data to maintain situational awareness.
- Sensor spoofing, jamming, and failures – key navigation sensors such as GPS, AIS, and radar can be affected by malicious external actions or technical malfunctions. To counter these threats, autonomous systems must have redundant sensor capacity, such as additional cameras and lidars to compensate for loss or distortion of data.
- Detection of exceptional events and signals – recognition of rare or unusual auditory and visual signals (e.g., light signals or distress signals) is extremely challenging for autonomous systems because such events rarely appear in training datasets, making correct identification difficult.

These extraordinary and unpredictable conditions necessitate the development of more robust, redundant, and adaptive situational awareness systems so that autonomous ships can operate safely in real maritime environments.

Cybersecurity Risk Assessment and Ethical Challenges

Cybersecurity is one of the most important aspects of autonomous ship operation, as these systems depend on continuous connectivity and data exchange via communication channels. Any breach or manipulation of these channels can jeopardize vessel safety.

Major cybersecurity risks include:

- Unauthorized access to remote control or maintenance systems, enabling malicious actors to take control or disrupt operations;
- Attacks on navigation and sensor systems, which can obstruct data acquisition or mislead the system through false information, such as:
- GPS signal jamming leading to loss of positioning;

- AIS message spoofing causing the ship to "believe" it is in another location or surrounded by non-existent objects.

Due to these threats, communication channels and associated systems must be designed with high levels of protection, including strong encryption, authentication, and continuous monitoring.

The introduction of autonomous ships also raises ethical and social challenges that cannot be resolved solely through technological or legal means. These challenges relate primarily to AI decision-making and responsibility for the consequences of such decisions. A central issue is algorithmic ethics—how to program AI systems to reflect human moral principles and priorities. In situations such as collision avoidance or emergency response, systems must act according to principles of human life protection, harm minimization, and environmental preservation. This raises difficulties such as:

- How to define what constitutes an "ethically correct" decision in a given situation;
- How to ensure transparency and traceability of algorithmic actions;
- Who should bear responsibility for system errors;
- The necessity for autonomous systems to prioritize human life over technical objectives;
- Ensuring fairness and non-discrimination in algorithms;
- Providing environmental responsibility in design and operation;
- Maintaining the possibility of human intervention in emergency situations.

Conclusion

Autonomous ships require changes in the training of maritime professionals. Although operation becomes increasingly automated, the human role remains essential, particularly in remote monitoring, control, and response in critical situations.

In the future, the International Maritime Organization must develop a unified international regime combining principles of traditional maritime law with new standards for autonomy, safety, cybersecurity, and accountability. This framework must ensure balance between innovation and security and clearly define responsibilities among states, operators, and technology developers. To guarantee safe and responsible use of autonomous technologies in maritime transport, internationally agreed ethical standards must be established to balance innovation with moral principles.

In addition to legal challenges, autonomous technologies require institutional coordination among maritime administrations, technological agencies, insurers, and international organizations. The International Maritime Organization must play a leading role in coordinating these efforts by developing unified standards, guidelines, and mechanisms for information exchange.

References

1. Bappy, M., Opi, A., Uddin, K., & Arzu, F. (2024). Opportunities and Challenges of Autonomous Vessels in Shipping – A Brief Systematic Review. Journal of Engineering and Technology (JET), 2, 27–42.

2. IMO. Autonomous shipping. Available at: https://www.imo.org/en/mediacentre/hottopics/pages/autonomousshipping.aspx

3. Kilinc, N. (2025). The Autonomous Revolution in Shipping: A Comprehensive Analysis of Design, Systems, and Global Trade. Available at: https://www.researchgate.net/publication/394267986

4. Ringbom, H., Viljanen, M., Poikonen, J., & Ilvessalo, S. (2020). Charting Regulatory Frameworks for Maritime Autonomous Surface Ship Testing, Pilots, and Commercial Deployments.

ОПТИМІЗАЦІЯ БЕЗВТРАТНИХ МЕТОДІВ СТИСНЕННЯ ЗОБРАЖЕНЬ

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OPTIMIZATION OF LOSSLESS IMAGE COMPRESSION METHODS

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Анотація

У представленій роботі розглянуто задачу безвтратного стиснення зображень на основі виявлення та усунення кодової і міжелементної надлишковості. Актуальність теми пов'язана зі зростанням обсягів графічної інформації та необхідністю її ефективного зберігання без втрати якості. У межах дослідження реалізовано програмний алгоритм, який поєднує предикативне (різницеве) кодування та кодування Хаффмана — два класичні методи стискання, що взаємодоповнюють одне одного. Предикативне кодування дозволяє зменшити просторову надлишковість за рахунок збереження різниць між сусідніми пікселями по горизонталі. Ці різниці потім стискаються методом Хаффмана, який забезпечує ефективне бінарне представлення значень відповідно до частоти їх появи. Особливістю роботи є не лише числовий аналіз, але й **вивід різницевого зображення,** що наочно демонструє ефект усунення надлишковості. Додатково реалізовано **обчислення нормалізованої автокореляції**, яка дає змогу оцінити просторову залежність пікселів і підтвердити ефективність застосованого підходу. Удосконалена версія алгоритму обмежує обчислення автокореляції лише до половини рядка, що покращує швидкодію та дає змогу краще дослідити локальні структури сигналу. Експериментальні результати доводять, що запропонований підхід дозволяє досягти стиснення на рівні **~28% без втрат інформації**, з повним відновленням зображення.

Abstract

The presented work considers the problem of lossless image compression based on the detection and elimination of code and inter-element redundancy. The relevance of the topic is associated with the growth of graphic information volumes and the need for its effective storage without loss of quality. As part of the research, a software algorithm was implemented that combines predicative (difference) coding and Huffman coding - two classical compression methods that complement each other. Predicative coding allows you to reduce spatial redundancy by preserving the differences between neighboring pixels horizontally. These differences are then compressed using the Huffman method, which provides an effective binary representation of values according to the frequency of their occurrence. A feature of the work is not only numerical analysis, but also the output of a difference image, which clearly demonstrates the effect of eliminating redundancy. Additionally, the calculation of normalized autocorrelation is implemented, which allows us to estimate the spatial dependence of pixels and confirm the effectiveness of the applied approach. The improved version of the algorithm limits the calculation of autocorrelation to only half of the line, which improves performance and allows us to better investigate local signal structures. Experimental results prove that the proposed approach allows us to achieve compression at the level of ~28% without loss of information, with full image recovery.

Ключові слова:стиснення зображень, кодова надлишковість, міжелементна надлишковість, гістограми зображень, параметр якості, коефіцієнт кореляції.

Keywords: image compression, code redundancy, inter-element redundancy, image histograms, quality parameter, correlation coefficient.

Вступ

Щоденно величезна кількість зображень запам'ятовується, перетворюється і передається у цифровому вигляді[1-7]. Стиск зображень є орієнтованим на вирішенні проблеми зменшення їх об'єму. Основою такого процесу є зменшення надлишкової інформації у зображеннях. З математичної точки зору це рівнозначне перетворення деякого масиву даних у статистично некорельований масив [8]. Таке перетворення стиску використовується до початкового масиву перед тим як його зберегти або передавати. У подальшому стиснутий масив розпаковується і відновлюються початкові дані або їх певне їх наближення. Термін «стиск даних» означає їх зменшення. Він використовується для представлення певної кількості інформації. При цьому як зазначалось раніше, між поняттями дані і інформація необхідно провести чітку відмінність. Вони не є синонімами. Дані фактично є тим засобом, за допомогою якого інформація передається. Для представлення однієї і тієї ж самої кількості інформації може бути використана різна кількість даних. Це має місце, наприклад, коли дві особи, одна з яких є багатослівною, а інша конкретною і лаконічною, повідомляють про одну у ту ж саму подію. У цьому випадку інформацією є факти про які йде мова, а слова -даними що використовуються для опису інформації. Якщо обидва оповідачі використовують різну кількість слів, то виникає два варіанти однієї

і тієї ж історії, причому хоча у одному з її варіантів будуть міститись несуттєві дані. Це означає що такий варіант містить дані (слова) які несуть або несуттєву інформацію, або є повторенням уже відомого. У такому випадку говориться про надлишковість даних.

Теоретична частина.

У багатьох прикладних задачах стиск без втрат є єдино допустимим способом скорочення об'єму даних. Одним з таких випадків є архівація медичних або ділових документів, де стиск з втратами є недопустимий. Інший приклад , це обробка супутникових зображень , де як отримання так і використання початкових даних роблять стиск з втратами небажаним. Тому, у даній роботі розглянуто метод стиску без втрат, які є актуальними на даний час. Такі методи забезпечують стиск у 2-10 разів. Як згадувалось раніше, алгоритми стиску без втрат складаються з двох незалежних операцій , а саме розробка альтернативного представлення зображень у якому зменшується міжелементна надлишковість та кодування отриманих даних для усунення кодової надлишковості. Ці кроки відповідають операції відображення і символьного кодування моделі джерела [6]. Основною метою стискання є зменшення обсягу інформації, необхідної для представлення цифрового зображення, при збереженні його основних характеристик. Використання методів стискання дозволяє скоротити витрати пам'яті, прискорити передавання файлів мережею та підвищити ефективність роботи інформаційних систем загалом. Важливою проблемою стиснення зображень є можливість їх подальшого відтворення без втрати інформації.

У теорії стискання даних використовують поняття коефіцієнта стиснення та відносної надлишковості. Коефіцієнт стиснення характеризує відношення обсягу початкових даних до обсягу стиснутих даних. Відносна надлишковість визначається згідно формули(1) і показує частку надлишкової інформації у початковому наборі даних:

$$R_D = 1 - \frac{1}{C_R} \quad (1)$$

де коефіцієнт стиснення заисується як:

$$C_R = \frac{n_1}{n_2} \quad (2)$$

Чим більшим є коефіцієнт стиснення, тим більшою є надлишковість даних. Для цифрових зображень це означає, що значна частина інформації може бути представлена у більш компактному вигляді без втрати важливих характеристик зображення.

Однією з причин можливості стискання цифрових зображень є нерівномірний розподіл значень яскравості. На практиці окремі рівні яскравості зустрічаються значно частіше за інші, проте під час звичайного двійкового представлення всі значення займають однакову кількість бітів. Такий спосіб подання даних не враховує статистичні особливості зображення та призводить до появи додаткового інформаційного резерву, який може бути використаний для зменшення обсягу даних [9,10].

Для опису ймовірності появи рівнів яскравості використовується статистичний розподіл з імовірністю $p_k(r_k)$ [9,10]:

$$p_r(r_k) = \frac{n_k}{n} \quad (3)$$

де $k = 0, 1, 2, \dots, L-1$, n_k-чисто мікселів, що володіють яскравістю r_k, а n – загальне число пікселів на зображенні. При цьому ,середня довжина кодового слова визначається як математичне сподівання довжин кодів:

$$L_{cp} = \sum_{k=0}^{L-1} l(r_k) p_r(r_k) \quad (4)$$

У випадку використання рівномірного двійкового коду величина середної довжини спрощується:

$$L_{cp} = m \quad (5)$$

Для усунення кодової надлишковості використовуються нерівномірні методи кодування, у яких короткі кодові слова призначаються найбільш імовірним символам. Найбільш відомим методом такого типу є алгоритм Хаффмана [11].

У більшості природних зображень характерною є плавна зміна яскравості між сусідніми ділянками. Через це, значення окремого пікселя часто можна приблизно оцінити на основі значень його найближчих сусідів. Наявність такої залежності між елементами зображення створює додаткові можливості для стискання даних та є однією з основних причин використання прогнозування і різницевих методів представлення інформації.

Для оцінки взаємозв'язків між пікселями використовується функція кореляції [5,6].

$$f(x,y) \cdot h(x,y) = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} f * (m,n) h(x+m, y+n) \quad (6)$$

У нормалізованому вигляді коефіцієнт автокореляції визначається:

$$\gamma(\Delta n) = \frac{A(\Delta n)}{A(0)} \quad (7)$$

де:

$$A(\Delta n) = \frac{1}{N-\Delta n} \sum_{y=0}^{N-1-\Delta n} f(x,y) f(x, y+\Delta n) \quad (8)$$

Для усунення міжелементної надлишковості використовуються різницеві методи представлення даних. У цьому випадку зберігаються не абсолютні значення пікселів, а різниці між сусідніми елементами. Це дозволяє суттєво зменшити ентропію даних та підвищити ефективність ентропійного кодування.

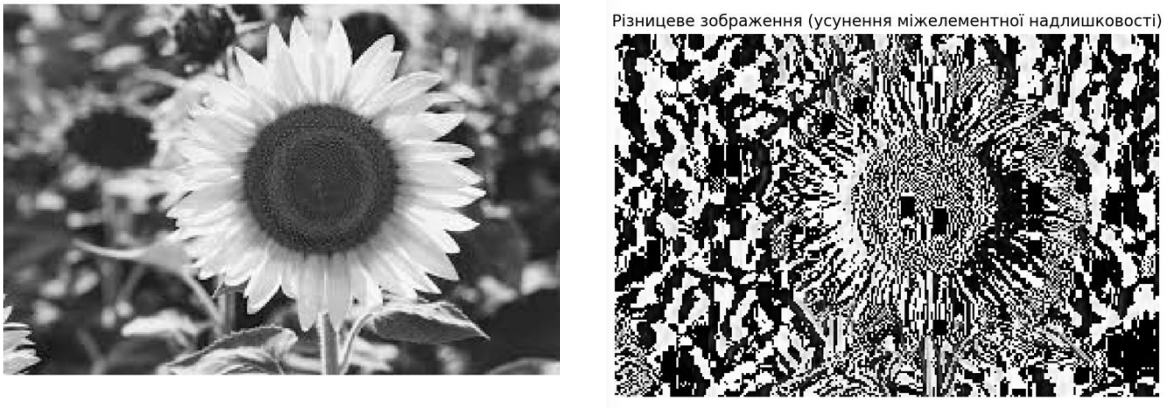
При оцінюванні якості відновлених зображень використовуються різноманітні об'єктивні критерії [6-10]. Найбільш поширеними є параметр якості (ПЯ):

$$R = 10 log_{10} \frac{(255)^2}{\frac{1}{MN} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [\hat{f}(x,y) - f(x,y)]^2} \quad (9)$$

який використовується у даній роботі для оцінювання правильності відновлення зображень після стискання.

Результати та їх обговорення.

Програмна реалізація алгоритму стиснення виконувалась високорівневою мовою програмування Python та складасась з низки послідовних етапів, кожен з яких відповідає окремому кроку стиснення зображення[12,13] . Структура програми побудована у вигляді одного основного сценарію з допоміжними функціями. У результаті було реалізовано програмний алгоритм безвтратного стиснення зображень, що ґрунтується на поєднанні предикативного (різницевого) кодування та методу Хаффмана. Такий підхід дозволив ефективно усувати як просторову, так і кодову надлишковість, що притаманна більшості цифрових зображень. Було розроблено повноцінний програмний модуль, який виконує всі етапи обробки: від завантаження зображення до відображення результатів та оцінки ефективності. Реалізація супроводжувалась візуалізацією різницевого зображення, гістограми частот, автокореляційної функції, а також виведенням оригінального та відтвореного зображень.

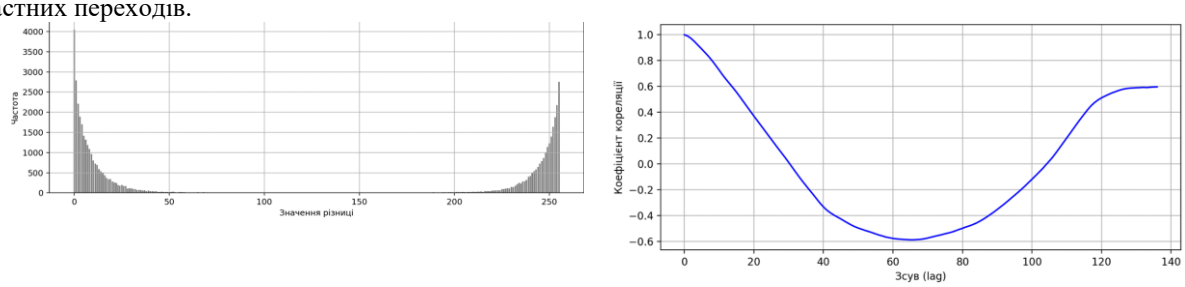


а *б*

Рис.1 Початкове дображення, яке піддавалось стисненню (а) та його різнецеве перетворення (б).

На Рис.1 представлено початкове зображення (а), яке піддавалось стисненню та його різнецеве перетворення. **Різницеве зображення** побудоване після предикативного кодування. Воно виводиться у відтінках сірого і демонструє, як змінилися значення пікселів після віднімання значень яскравості сусідів. Як видно з Рис.1б, структура зображення стає спрощеною, зменшується кількість різко контрастних переходів.

Проводилось також дослідження стиснення початкового зображення із використанням окремих методів зменшення надлишковості даних так і їх комбінації. На Рис.2 показано гістограму перетвореного різнецевого зображення (а) та обчислений за формулою 7 нормалізований коефіієнт кореляції (б).



а *б*

Рис.2. Гістограма різнецевого зображення (а) та його коефіцієнт кореляції (б)

Гістограма різниць показує частотний розподіл різниць між сусідніми пікселями. Як правило, найчастіше зустрічаються значення близькі до нуля, що створює сприятливі умови кодування методом Хаффмана. Крім того, графіки гістограми різниць та нормалізованої автокореляції підтверджують наявність значної надлишковості у початкових даних, що обґрунтовує доцільність застосування описаного підходу.

Рис. 3 Відтворене зображення.

Як показали дослідження, найвищу ефективність стиску без втрат забезпечує поєднання методів усунення міжелементної та кодової надлишковості. Спочатку зображенні зменшувались шляхом усунення просторові залежності, після чого отримані дані кодувались з використанням статистично оптимальних кодів. Такий підхід дозволив наблизити середню довжину коду до ентропійної межі та є теоретичною основою більшості сучасних алгоритмів стиску зображень без втрат. Результати експериментів підтвердили коректність роботи алгоритму. Досягнуто коефіцієнта стиснення, який рівний 3,57 а надлишковість даних, згідно виразу (2), який ще можна переписати у вигляді:

$$C = \frac{n_2 - n_1}{n_2} \tag{10}$$

становить 0,72.

У ряді випадків спотворення зображень супроводжується втратою реальної кількісної інформації. Оскільки при цьому можуть бути втрачені і важливі дані, то бажано мати засоби кількісної оцінки характеру і величини втрати інформації. У нашому випадку для оцінки ефектів стиснення найбільш ефективним виявився параметр якості R (ПЯ), який визначає відносну зміну якості відтвореного зображення порівняно із початковим. Обчислений згідно формули (9) коефіцієнт $R \to \infty$ що підтверджує високу ступінь безвтратного стиснення.

Отримані результати демонструють, що комбіноване використання предикативного кодування та методу Хаффмана дозволяє досягти доброго стиснення без втрат, з істотним зменшенням коду зображення, що значно покращує існуючі методи [14-16].

References

1. Згуровський М.З., І.І. Коваленко В.М. Михайленко. Вступ до комп'ютерних інформаційних технологій; [навч. посіб] -К.; Вид-во Європ., ун-ту, 2002.265с.

2. James L. Massey. Applied Digital Information Theory. Lecture Notes-ETH Zurich,1998,153P.

3. Kennth R. Trust in digital information.Journal of American Society for Information Science and Technology, Vol.59,Issue 3, 2008 ,pp.363-374.

4. Б.П.Довгий, Є. С. Вакал. Інформаційні системи та технології. Навчальний посібник для студентів механіко-математичного факультету . – К.: 2021. – 111 С.

5. Наконечний А., Наконечний Р., Павліш В. «Цифрова обробка зображень». Видавництво Львівської політехніки.2010 С.366

6. R.C. Gonzalez, E.R. Woods, "Digital Image Processing" Second Edition Prentice Hall Upper Saddle River, New Jersey 07458, 2017. P. 797

8. Shannon C. E. A Mathematical Theory of Communication // Bell System Technical Journal. – 1948. – Vol. 27. – P. 379–423, 623–656.

9. Buccafurri F., Rosaci D., Sacc`a D.: Improving Range Query Estimation on Histograms. ICDE 2002.pp. 628-238.

10. Aboulnaga A., Chaudhuri S.: Self-tuning Histograms: Building Histograms Without Looking at Data. SIGMOD Conf. 1999. pp. 181-192.

11. Huffman D. A. A Method for the Construction of Minimum-Redundancy Codes // Proceedings of the IRE. – 1952. – Vol. 40, No. 9. – P. 1098–1101.

12. Harris C. R. et al. Array Programming with NumPy // Nature. – 2020. – Vol. 585. – P. 357–362.

13. Hunter J. D. Matplotlib: A 2D Graphics Environment // Computing in Science & Engineering. – 2007. – Vol. 9, No. 3. – P. 90–95.

14. Pennebaker W. B., Mitchell J. L. JPEG: Still Image Data Compression Standard. – New York : Springer, 1993. – 650 p.

15. Taubman D. S., Marcellin M. W. JPEG2000 Image Compression Fundamentals, Standards and Practice. – Boston : Springer, 2002. – 791 p.

16. І. Половинко, Н. Ліпковський, Ю. Фургала. Кількісна оціна вейвлетного стиснення зображень// Електроніка та інформаційні технології. – 2024. – 25. – С. 14-29.

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